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AGRICULTURAL ENGINEERING

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Let the Farmer Farm

AS A MEMBER of American Engineering Council, the American Society of Agricultural Engineers is co-operating from the standpoint of agriculture in a broad study by Council into the relation of consumption, production, and distribution. Among the many questions being investigated is that of the possibility and desirability of farm industry. As construed by those whose opinions we have seen this means the manufacture or processing of (a) non-agricultural materials, or (b) of farm products, presumably on the farm where produced.

Barring sporadically successful cases of mixed businesses, the consensus thus far seems to be that manufacture of unrelated materials on the farm is neither desirable nor promising. As to processing or manufacture of the farmer's own products the outlook is but little more promising. It is suggested that, for the most part, such processing should be merely preliminary for more efficient transport, storage, or subsequent manufacture.

Obvious as these views may seem to us, it will be wise to have them well defined and fortified as an antidote to the ingenious, not to say devious, remedies proposed for what ails agriculture and the whole body politic. The reasons for our somewhat dogmatic assertion are both economic and what—for lack of a better word—we may call psychological.

While farm buttermaking is far from a lost art, and homemade butter still may be a rare treat, it is pretty well established that better butter is made at lower cost in the creamery. The farm cannot justify the investment in equipment, in specialized training, or of labor time, to equal the creamery. The same is true as to the slaughter and processing of meat products for general markets. It is true of canning fruits and vegetables for market. The same is true of products for consumption on the farm. Home mixing of fertilizers and spray materials has steadily yielded to products commercially prepared, despite more or less of propaganda and profiteering. Within the limits set by transportation and distribution costs, the whole trend has been toward more specializing and more specialists.

While lower interest rates may alter the situation from the angle of investment in efficient equipment, the barrier of specialized skill will remain as long as farming is done mainly on a family-unit basis. Farming already is so technical as to tax the capacity of the human mind to absorb and apply information, skyscraper wiseacres to the contrary notwithstanding. Not until corporation farming, or some type of industrialized agriculture, comes into being will the farm staff be large enough to have specialists for canning fruit, curing meat, making butter, and so on. Much less will unrelated processing be done competently.

The agricultural engineering profession is trying to teach farmers the intricacies of internal-combustion engines, electricity, hydraulics, and soil mechanics, not to mention buildings and fences. We must needs be subdivided into specialists to advise him competently, yet we are but one among soil chemists, agronomists, geneticists, entomologists, and so on almost *ad infinitum*. It would be indeed a superfarmer who could find time and brain room for the lore of paper making, distilling, textiles, or metals manufacture.

Let decentralization of industry make its way on its own merits, until perchance every farm has a factory for a neighbor, but it will keep the farmer busy to do a good job of farming.

Cutting Edges and Materials

THE STUDY of cutting edges of tillage implements reported elsewhere in these pages by Zink, Sellers, and Roberts deserves emphasis not alone for the progress made and the findings stated, but as an avenue of further and broader research. It is hardly too harsh to say that the plowshare and the cultivator shovel have hidden too long in the complacent shadow of the spreading chestnut tree, of village smithy fame.

Speed as a factor in implement design and the wear and performance of cutting members is a field but little explored, yet one which seems inevitable if pneumatic tractor tires are to bear out their promise. Tractor design already has outrun that of implements. The latter will follow, but in the interest of efficiency the implement designer should have available in advance fundamental data on the characteristics of all metals and treatments that are or may be used in the construction of tillage members.

This study is of especial interest among ASAE members because it sooner or later has figured in nearly every discussion or activity in the field of materials for agricultural engineering. We trust that with this impetus more rapid progress may follow in all phases of materials engineering.

After the Fullness of Years

IN THE BRIEF perspective of a mere month since this Society, America, and the world suffered the loss of Elwood Mead and John Jacob Glessner, it is difficult to look beyond the sorrows that inevitably attend their passing. Yet we begin to be impressed with the greatness of the heritage which these men have left us as our permanent possession. Ripe in the fullness not alone of years but of achievement at their time of passing, they have endowed us and generations to come with tremendous assets, both tangible and intangible.

Of lesser figures some epitome might here be given of works accomplished. Of Messrs. Mead and Glessner be it said that their lives, and to a large degree their active participation, spanned the modern epoch in two major realms of

agricultural engineering—land reclamation and soil and water conservation, and farm machinery and power, respectively. To mention Boulder Dam or the Champion line of harvesting machinery would be either the beginning of a vast enumeration or else emphasis on items where whole careers should be considered.

At 78, Dr. Mead was the active and actual commissioner of the Bureau of Reclamation in the Department of the Interior, and we have yet to hear the faintest intimation that he was old. On the eve of his 93d birthday, Mr. Glessner was, as he had been for more than a third of a century, director in the International Harvester Company. In terms of human engineering, their lives just closed remain living refutation of the doctrine that years must make way for youth, experience for energy and enthusiasm.

At 60, Dr. Mead was professor of rural institutions at the University of California, and chairman of the state land settlement board. Not until six years later did he assume the responsibilities of federal Commissioner of Reclamation. After that he served on the United States-Mexico International Water Commission; received the LLD degree from the University of Michigan, made visits to Haiti as consultant on irrigation and to Cuba as consultant on hydraulic development; attended a Pan-Pacific conference in Hawaii; went to Palestine as investigator and expert in land settlement; and was the guiding spirit in the execution of the Boulder Dam project. Since his sixtieth birthday he was author of articles, books, addresses, reports and official statements to the number of 115. Surely this is a long way from pension, armchair, and whittling stick.

Of Mr. Glessner we have at hand no such detailed record, but we know that he was in his sixtieth year when the International Harvester Company was formed; concluded a period as chairman of the executive committee at 63; and resigned as a vice-president at 76. From his start at 20 with Warder and Childs to his passing, in harness, as a Harvester director he had served more than 72 years in the farm machinery industry.

These are exceptional records, and they were made by exceptional men. They do not nullify the case for retirements, pensions, and other measures for old-age security. Neither do they obscure the claim of youth for succession to the responsibility to which age, without such security, may be forced to cling. But they do indicate that for exceptional men exceptions should be made—that retirement should be not a mandatory thing based on age alone, but with a large degree of flexibility based on the merits of the case and the choice of the individual.

In the wisdom of their administration, one in the realm of public works and the other of private industry, these departed Honorary Members of the American Society of Agricultural Engineers have created opportunity for young men and builded toward security for men, women, and children of all ages and stations. We mourn their passing, but more especially we rejoice that they lived so long and served so wisely.

Agricultural Engineering Marches On

NEVER BEFORE in the life of the American Society of Agricultural Engineers has the Secretary's office received so many notices from members of changes in address, title, or connection. To some extent this is merely a matter of more members involving more changes, but there seem to be other causes and trends.

The rapid evolution and expansion of soil erosion control and other conservation work, with changes in organization and shifts of men, is a prominent factor. Not only this but other phases of federal activity have involved a large amount of "borrowing" from state institutions, with more or less return of such men. Much of this began as one sort or another of emergency or recovery expedient. Now there is in apparent progress a reclassification into temporary activity which can be discontinued, and more permanent work to be maintained.

Another trend which seems to tell a story of healthy activity in private enterprise of the drafting, here and there, of engineers from the state colleges or other public employment into industries serving agriculture. This makes way for advancement and replacement through sundry ranks in what we call broadly the "educational" wing of the profession. Most, but by no means all, of these shifts in both public and private employment, and between them, are among the younger engineers.

The bird's-eye impression gained from handling these membership records is that the industries allied with agricultural engineering are steadily gaining in activity and confidence. More than that, it seems that the profession of agricultural engineering is playing an ever larger part in both private and public enterprise. Not only as a profession, but as individuals, we are advancing.

Underconsumption

"UNDERCONSUMPTION" is the word used by L. F. Livingston, president of the American Society of Agricultural Engineers, to more accurately picture the mutual problem of farmers and industrialists which has commonly been called "overproduction."

In a recent address at Kalamazoo College on the event of its annual Rural Progress Day exercises he amplified this viewpoint, saying "The problems of both the farmer and the industrialist will be solved if and when markets for their products are developed."

Speaking of the non-farming population he continued, "This great group of people which for one reason or another consumes less than its full capacity, constitutes an important, and as yet imperfectly developed market . . . . . The problem is to restore and stabilize the balance between the cost of food production and the ability of the consumer to pay." This is in line with remarks quoted in a February editorial, to the effect that in the United States average food consumption provides its citizens on the average a third-class diet, and that to provide food for domestic consumption at the standard of even a second-class diet, more acres would have to be put into production.

But in pointing out opportunities for increasing consumption Mr. Livingston does not stop there. He goes on to emphasize the growing new field of chemical industries and the raw materials they consume which can be produced by farmers.

"Overproduction" then is merely an apprehensive, hindsighted condition of engineering-born agricultural and industrial production progress for having outgrown some imaginary status quo. "Underconsumption" is a forward-looking engineers' analysis; a one-word-picture of a current limiting factor in social progress; a problem for engineers to face methodically and with matter-of-fact confidence.

Results of Studies of the Cutting Edges of Tillage Implements

By Frank. J. Zink, G. A. Sellers, and June Roberts

THIS PAPER is a progress report of a study of those parts of tillage implements which function in the soil. More specifically, it relates to a study of the cutting edges of plowshares, particularly their wearing characteristics.

The research in its entirety is outlined toward a study of tillage implement materials, usually ferrous metals, consisting of those parts of plows, disks, spading tools, shovels, and other farm machine parts which cut, slice, lift, turn, pulverize, or change the position of the soil. These parts which function in the soil are normally prepared with cutting edges. The study will include also special treatment of the cutting edges as accomplished through different hard-surfacing alloy metals applied to the edges. These edges are the most important part of a unit and change considerable during the operation of a tillage machine. They are subjected to abrasive action of the soil, and possibly, to a certain degree, to chemical action of soil constituents. In this consideration the soil may be regarded as a finely divided grinding compound composed of organic and inorganic materials.

The maintenance of cutting edges is a considerable item of the cost of production. Observations indicate that this cost amounts to about 10 per cent of the total cash outlay for plowing at least in certain regions, which expense does not include lost time or travel expense in changing or renewing the cutting edges. Other items of importance also are the factors of waste of power through the use of dull or partially dull tools, faulty machine operation, and inefficient results from the implement.

A number of changing conditions are tending to focus attention to this subject. Much of the skill of the country blacksmith has been lost and more profitable enterprizes are being substituted for this trade, although there is the question as to whether or not adequate service has ever been rendered by blacksmiths in the proper handling and heat-treatment of plow steels. Few shops are equipped with the necessary appliances for satisfactory heat-treatment, and where available, the work is done largely by rule-of-thumb methods. Such practices are not conducive to desired results and would not be tolerated in scientific shop practice. Other changes which are becoming more important are substitution of mechanical for animal power, higher travel speeds, faster moving parts, and, to some degree, new applications of tillage practice involving more scientific soil management.

Many improvements have been made in metals used in various industries. In fact, these changes are the very substance of the existence of a number of our later industries. No one will deny that tillage implement materials have not kept pace with other developments in the field of metallurgy. At the present time there are few specifications for the composition, heat-treatment, and hardness of tillage steels which meet with universal approval by manufacturers. They differ widely in their specifications, except perhaps the factor of hardness. Yet the hardness which is specified is rarely found after the first job of sharpening of steel shares. Hardness in this paper, as used above and subsequently, refers to resistance to indentation rather than resistance to abrasion as may be found in some of the metallurgical literature. In this study the authors wish to adhere to the definition of hardness that it is "the ability of one substance forcibly to penetrate another substance."

There are no basic or scientific data supporting present practice in the selection of tillage implement materials. Present practice is traditional to a degree. It is being more frequently questioned, and obviously when plowshares have to be resharpened as frequently as two and three times per day, present practice is not all that is to be desired.

To make a fundamental and basic study of the requirements of tillage implement cutting edges and with the hope that a certain economic contribution could be made, this problem was formally outlined as one of the researches under the auspices of the Kansas Engineering Experiment Station. The study is carried on cooperatively between the Department of Agricultural Engineering and the Department of Shop Practice under which the metallurgical work is administered. Of the several objectives outlined, but two have received attention and study. These relate to the maintenance of cutting edges as influenced by different steels to withstand soil abrasion and the determination of the physical characteristics of work done in a few blacksmith shops. Since plow materials are of most importance, the study thus far has been confined to these units. It is thought also that any discoveries made on these devices may be applicable, in part, to other tillage implements.

A previous review of the literature on wear resistance reveals that numerous wear-test procedures have been developed, but none could be located with reference to soil wear. The literature indicates that wear is dependent upon conditions at hand and that there is no suitable general means of studying wear. Therefore, the devices for study on a laboratory scale take several different forms, each assumed to approach the conditions of the application. While some study has been made of wear of materials in service, the published reports relate mostly to laboratory methods.

After the conception of this work and the study was under way, some references were located concerning soil wear of ferrous metals. These studies are being conducted in Germany and, like this study, are in progress.

It is obvious that two distinct variable relationships exist. The first of these is very complex and relates to soil. Some of the factors met in this phase are roots, trash, compactness, soil moisture, and soil type. The second group of factors relates to the composition of the metals used

Contribution No. 77 of the Department of Agricultural Engineering and No. 136 of the Department of Shop Practice, Kansas Engineering Experiment Station. Released for first publication in AGRICULTURAL ENGINEERING. (Note: Mr. Roberts presented a resume of this work before the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 2, 1935.)

Authors: Respectively, associate professor of agricultural engineering (Mem. ASAE), professor of metallury and metallography, and instructor in agricultural engineering (Assoc. Mem. ASAE), Kansas State College.

primarily in the cutting edges. Some of these factors are hardness, composition, mechanical and heat-treatment, strength, ability to scour, ability to resist wear, and doubtless others of more or less importance. There is no doubt another group, less apparent perhaps, which is composed of those factors interrelating between these two groups.

Therefore, at the outset of this study it is recognized that but little progress can be made unless the factors are narrowed down so that independent study can be made of each with all other influencing factors under control or at least under partial control. The segregation and the weighing of the factors will only be possible, no doubt, after extended research on this subject.

To bring factors under control, a wear-test machine was planned in the beginning of the research. The main requirement of the machine was that it should duplicate as nearly as possible the field conditions under which tillage machines operate.

By laboratory testing it is thought possible to make many comparisons of materials and to study those factors relating to materials. Therefore, a test machine was devised whereby a number of specimens of small size could be subjected to practically the same wearing conditions throughout a test.

The wear-test machine shown by Fig. 1 was constructed chiefly of old tractor parts, a 5-horsepower electric motor, and the necessary power transmission apparatus. The soil in the trough-shaped pan is rotated against the specimens at approximately plowing speeds. Speed changes are made by changing pulleys on the motor and counter shaft. To date, however, but one average speed, that of 2.3 miles per hour, has been used. The specimens are given an oscillating motion by a cam and push rods. The cam is driven by a ratchet and pawl mounted on the final driveshaft. By this means the specimens not only move back and forth in a simple harmonic motion across and at right angles to the rotating pan, but also they remain stationary a part of the time. This oscillating motion is to prevent the specimens from traveling in the same path, a condition which would result in not using all the soil in the pan.

The specimen holders shown by Fig. 2 are mounted on arms pivoted above the machine. The holder and the arm are telescoping pipes locked together by means of a bolt.

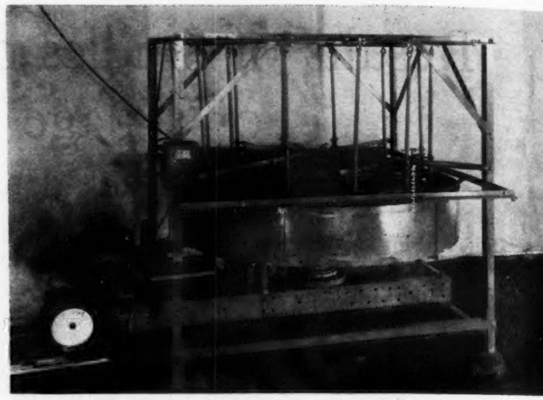

FIG. 1 WEAR TEST MACHINE USED FOR STUDYING WEAR OF DIFFERENT METAL SPECIMENS AT THE KANSAS ENGINEERING EXPERIMENT STATION

The specimens, also shown by Fig. 2, are mounted on the holder at an angle of 30 degrees with the horizontal by means of a plow bolt. This angle was obtained by trial of a number of plowshares on which measurements were taken one-fourth the distance from the plow point. The specimens are 2 inches wide by 4 inches long by 1/4 or 5/16 inch in thickness. The 1/4-inch specimen has been used in the majority of the tests. The specimens are held with the edges parallel to the radii of the circular soil pan. The cutting edges of the specimens are ground at a 30-degree angle formed by the top surface and the finished ground surface.

The specimens were cut from bar stock, drilled for 5/16-inch plow bolts, numbered and center-punched at equal intervals along the rear edge of under surface. These center-punch marks served as reference points at which all width measurements were taken. The specimens were then treated or handled in accordance with the outline of the experiment.

The equipment used for the heat-treating of the specimens consisted of a General Electric, type RRB, 11-kilowatt furnace with a Leeds and Northrup automatic recorder and controller, also a General Electric, type AD, 5-kilowatt air-draw oven with a Bristol bulb type controller.

After heat-treatment, the hardness by Rockwell machine was taken along the forward edge of the specimen. Thence the specimens were sharpened by beveling the cutting edge. The hardness indentation marks were removed in the sharpening procedure.

In sharpening, the specimens were placed in a multiple holder, especially devised for the purpose, mounted on a 10-36 Norton, plain, wet cylindrical grinder. A 20-inch diameter, grain 3846 grade K, Alundum, vitrified wheel was used for the hardened and tempered tool steel as well as for the mild steel.

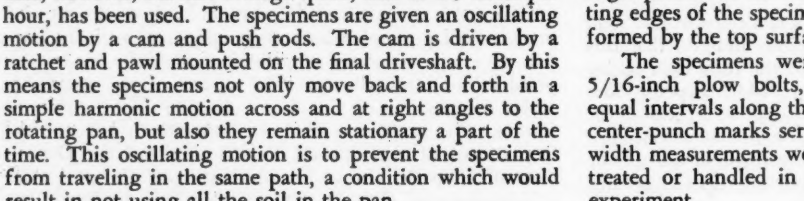

FIG. 3 RESULTS OF LABORATORY TEST MACHINE IN MEASURING EXTENT OF WEAR

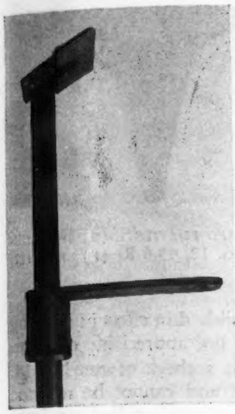

FIG. 2 THE METAL SPECIMEN AND THE SPECIMEN HOLDER

A crystolon wheel, grain 3736 grade K, was used on the chilled cast iron specimens. A copious supply of coolant flowed over the specimens during the sharpening operation so that the cutting edges would not be affected by the heat of the grinding process. The specimens were then carefully cleaned, accurately weighed to the nearest milligram, and measured across the width with a micrometer at the center-punch reference marks. Width measurements reported are the mean of five measurements on each specimen. These data, along with hardness by Rockwell machine, and the original specifications and information on treatment furnished the history of the specimen before and after test. The specimens are alike, made so through the use of machine tools and the multiple holder for the grinder.

In the testing procedure the samples were bolted to the holder and the machine operated over a 100-hour period. After the tests the specimens were again cleaned, measured, and weighed to determine wear. The wear is expressed by two measurements—weight loss in milligrams per 100 hours and mean width loss in thousandths of inches per 100 hours. Following this, if certain curious phenomena occurred, the specimens were cross-sectioned, ground, polished by machine, etched, photomicrographed, and studied as desired. It is considered that measurements of this type are a reasonably accurate means of reporting extent of wear.

RESULTS OF LABORATORY WEAR TESTING

Some of the results which have been obtained are shown by Figs. 3 and 4. These figures illustrate by column graph the data obtained on test runs Nos. 6 to 26, inclusive, each test comparing twelve specimens. The height of the columns represents the Rockwell hardness of the material, the weight loss, and the width loss.

This group includes tests to determine the effect of different soils upon the wear resistance of materials, the relation of hardness to wear resistance, the effect of soil moisture upon wear resistance, and the effect of the direction of flow lines upon the wear resistance of specimens. This latter refers to the direction of specimen travel related to the direction in which the steel plate was rolled. In this report it is considered, because of a lack of a better method of measurement, that wear resistance is to a considerable degree a measure of the durability of the material.

Test Nos. 6A and 6B on SAE 1095 steel, cut from the same bars, Figs. 3 and 4, are check runs in which the specimens were tested 100 hours, measurements were taken and then, without resharpening, again compared by resuming the wearing influences for another 100 hours. The weight loss was comparable in both cases. The decreased width loss of test No. 6B over test No. 6A was doubtless due to the increased bluntness of the cutting edges. The agreement of the results of check specimens may be noted in these tests. The records indicate that the wear resistance obtained was inversely related to the penetration hardness, although this relationship is not well defined. The heat-treatments given were as follows: Specimens 1 and 2, heat to 1460 degrees (Fahrenheit), water quench, no draw; 3 and 4, same, draw 450 degrees; 5 and 6, same, draw 600 degrees; 7 and 8, same, draw 800 degrees; 9 and 10, same, completely normalized; and 11 and 12, "as received" condition.

Test No. 8 compares SAE 1095 steel with Vanadium tool steel. The Vanadium tool steel had approximately 0.007-inch surface decarburization, hence it was not possible to fully harden this material without removing the decarburized surface. The low-carbon areas were not ground off on the heat-treated specimens. The specimens of this test were prepared as follows: 1, 2, 3, and 4, Vanadium tool steel, "as received"; 5, 6, 7, and 8, SAE 1095 steel, "as received"; 9 and 10, Vanadium tool steel, heat to 1465 degrees, water quench, draw 450 degrees; and 11 and 12, Vanadium tool steel, heat to 1465 degrees, water quench, no draw. The results of this comparison indicate that the SAE 1095 steel changed less than the Vanadium tool steel.

Test No. 9 was made on SAE 1020 steel. All specimens were cut from the same bars, and the material was left in the "as received" condition. The purpose of this series was to determine variations between specimens tested on the same low-carbon material. The results were uniform, except for additional width loss of specimen 8, which is unaccounted for.

Test No. 10 also was made on SAE 1020 steel to determine possible differences in wear due to direction of flow

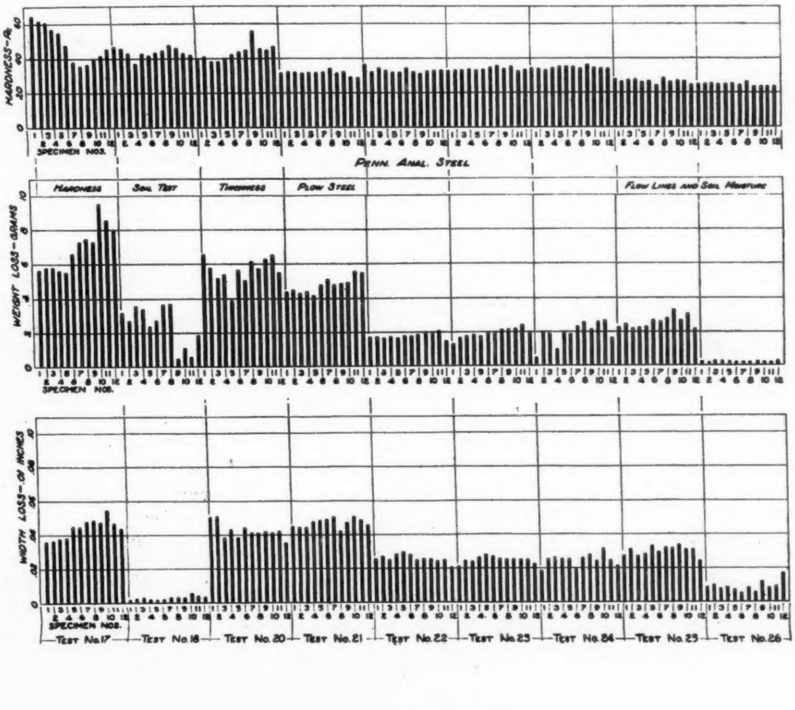

FIG. 4 RESULTS OF LABORATORY TEST MACHINE IN MEASURING EXTENT OF WEAR. (CONTINUATION OF FIG. 3)

FIG. 5 PHOTOMICROGRAPH SECTIONS OF TEST SPECIMENS (50 DIAMETERS) IN TEST NO. 17. (A) AS PREPARED FOR TEST. (B) SPECIMEN NO. 1, 64.1 Rc HARDNESS. (C) SPECIMEN NO. 4, 56.6 Rc. (D) SPECIMEN NO. 6, 47.6 Rc (E) SPECIMEN NO. 12, 45.6 Rc (F) SPECIMEN NO. 9, 36.3 Rc. (G) SPECIMEN NO. 8, 35.3 Rc

lines in relation to direction of travel. All specimens were run in the "as received" condition. Specimens Nos. 1, 3, 5, 7, 9, and 11 were cut and mounted so that the flow lines would be parallel to the direction of travel. The remaining or even numbered specimens were cut and mounted with flow lines crosswise to the direction of travel. In all other characteristics the specimens were alike. The width loss was less for specimens with flow lines at right angles to travel. The weight loss was less for flow lines parallel to travel. The differences are slight and not taken to be significant.

Test No. 11 was run on steel purchased on a so-called Pennsylvania analysis which according to the company selling the material is essentially the same as SAE 1095 in chemical composition. The test was conducted with the material in condition "as received" in order to determine variation of results between specimens. The results were very uniform as may be noted.

Test No. 13 was made on SAE 1095 Pennsylvania analysis steel and was also run to determine the influence of the direction of flow lines upon wear resistance. Specimens 1 to 6, inclusive, were tested with flow lines parallel to travel, and specimens 7 to 12, inclusive, with flow lines at right angles to direction of travel. Except for this difference the specimens were alike. In weight loss there existed only slight differences. In width loss, however, the specimens with flow lines parallel to direction of travel lost a significantly greater amount than the specimens with cross flow lines. Since this loss is definitely width, it is seemingly apparent that the loss must have occurred along the cutting edge.

Test No. 14 was made on chilled cast iron specimens in comparison with SAE 1095 Pennsylvania analysis steel. The cast iron specimens were made in the college foundry with a specially designed cast iron mold which shaped the cutting edge. Specimens 1, 3, 4, 5, and 6 were chilled cast iron sharpened as from the permanent mold. Specimens 2, 7, and 8 were SAE 1095 steel in the "as received" condition. Specimens 9, 10, 11, and 12 were chilled cast iron with a portion of the chilled top surface ground off to simulate a worn, chilled, cast plowshare condition. This removal of the superficial surface left the wearing portions in the chilled condition. Classed according to weight loss, the surfaced cast iron wore off the greatest amount, the unsurfaced cast iron next, and the steel showed greatest wear resistance. Classed according to width loss, the surfaced cast iron gave the greatest loss, the steel second, and the unsurfaced cast iron the least loss.

Test No. 15, SAE 1095 Pennsylvania analysis steel, was run to examine the effect of surface decarburization on wear resistance. Check samples were prepared as follows: 1 and 2, as cut from bar; 3 and 4, 0.002 inch depth of surface removed; 5 and 6, 0.004 inch; 7 and 8, 0.006 inch; 9 and 10, 0.008 inch; and 11 and 12, 0.010 inch removed, respectively. The specimens were otherwise untreated. The results indicate that the width loss was less with the unsurfaced material indicating a possible skin effect in reducing wear. Otherwise the results were not appreciably different.

Test No. 16 was conducted as a check of run No. 14. A part of the records were lost and cannot be reported here. The material tested was a series of chilled cast irons made in the college foundry. Specimens 1 to 8, inclusive, were tested with the surface untreated. Specimens 9 to 12, inclusive, were surfaced, 0.010 inch being removed. In this test the weight loss of the surfaced specimens averaged somewhat less than the unsurfaced.

Test No. 17 was made to determine the effect of Rockwell hardness on wear resistance, SAE 1095 Pennsylvania analysis steel being used. The specimens were prepared as follows: 1 and 2 heat to 1460 degrees, quench in 70-degree water, no draw; 3 and 4, same, draw 375 degrees; 5 and 6, same, draw 500 degrees; 7 and 8, same, draw 570 degrees; 9 and 10, same, draw 660 degrees; and 11 and 12, same, draw 700 degrees. Again the results indicate an inverse relation to hardness for both width and weight loss. However, the difference is somewhat more marked in this test as compared with 6A and 6B tests.

Attention is here directed to Fig. 5 which shows cross sections of the various cutting edges of the test specimens after completion of the run. These photomicrographic sections indicate that as the hardness increases, the cutting edges are maintained longer.

Test No. 18 was conducted to learn what difference in wear a loam soil would show as compared to a river sand having a fineness modulus of 3.5 and containing 2.5 per cent clay. SAE 1095 Pennsylvania analysis steel was used in the test. All samples were alike and in condition as received. The width loss with loam soil was less, although more uniform than was obtained with the sand. The weight loss is considerable with the loam soil, although less uniform and less in extent than was obtained with sand.

Test No. 19 was omitted.

Test No. 20 was made again with sand which contained about 2.5 per cent clay. In this test it was desired to determine the effect of removing a surface layer from heat-treated specimens. A steel bar 2 inches by 5/16 inch in thickness was prepared by heating it to slightly above its critical temperature and quenching it in water and with no draw. The specimens were then prepared in the usual manner. Specimens 1 and 2 were unsurfaced. The surface of the others was removed as follows: 3 and 4, 0.020 inch; 5 and 6, 0.040 inch; 7 and 8, 0.060 inch; 9 and 10, 0.080 inch; and 11 and 12, 0.100 inch removed, respectively. The results showed no appreciable difference in extent of wear.

Test No. 21 was run to compare SAE 1095 Pennsylvania analysis steel with a commercial plow steel used in plow repair work which was obtained at a local blacksmith shop. The specifications of this plow steel were unknown. Specimens 1 to 10, inclusive, were SAE 1095, and 11 and 12 plow repair steel. The plow repair steel was somewhat less

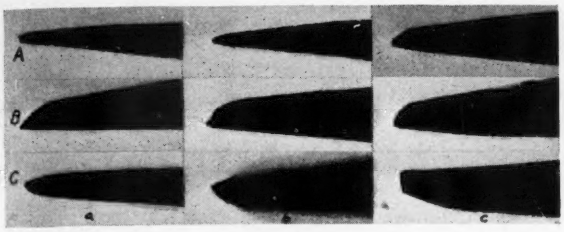

FIG. 6 PHOTOMACROGRAPH SECTIONS OF EDGES OF PLOWSHARES (4 DIAMETERS). ROWS A, B, C—RESHARPENED, WORN, AND NEW EDGES, RESPECTIVELY. COLUMNS A, B, AND C—STEEL, SOFT-CENTER STEEL, AND CHILLED CAST IRON SHARES, RESPECTIVELY

hard, and weight loss in the test was slightly greater; however, the results are not thought to be significantly different.

Test Nos. 22, 23, and 24 were similar to Test No. 11 and were made to determine the variation of results due to the wear-test machine. The specimens were all SAE 1095 Pennsylvania analysis steel cut from the same bars in the "as received" condition. It was considered that they should be alike in so far as it was commercially possible to obtain them so. These data show variations of results only slightly greater than the variations existing between specimens of the same stock. Variations exist between runs which was attributed largely to moisture differences of the sand or soil in the tests. It was not possible thus far in the tests to control moisture precisely.

Test Nos. 25 and 26 were run to determine the effect of moisture upon the abrasive qualities of the sand and to compare effect on wear due to direction of flow lines. SAE 1095 Pennsylvania analysis steel was used "as received." In Test No. 25, specimens 1 to 6, inclusive, were tested with flow lines at right angles to travel direction. Specimens 7 to 12, inclusive, were run with flow lines parallel to travel direction. The sand was moist, averaging 1.85 per cent dry weight basis. In weight loss, parallel flow line specimens averaged 2.704 grams, the cross flow lines 2.32 grams; in width loss, parallel 0.031 inch and cross 0.030 inch. These results on flow line differences do not appear significantly different. In Test No. 26 with dry sand, 0.19 per cent moisture, dry basis, specimens 1 to 6, inclusive, were run with cross flow lines, and 7 to 12, inclusive, with flow lines parallel to direction of travel, respectively. In weight loss the parallel flow line specimens decreased a mean of 0.010 gram, and cross flow line specimens, 0.010 gram. In width loss, parallel, 0.011 inch, and cross, 0.008 inch. The results of this test also were not thought to be significant.

Comparing the two tests, 25 and 26, shows that the moistened sand wears much more rapidly, the weight loss being about twenty times that of dry sand, and the width loss about three times that of dry sand.

In these tests, except for No. 18 where a loam soil was used, river sand has been used throughout all tests. This sand is of a type somewhat dirty for concrete work containing about 2.5 per cent clay. Some gravel was also present in it, but comparatively free of organic materials other than that simulating clay. The gradation factor of this sand has not changed materially over a period of use of 500 hours. The average of two tests of fineness at the beginning and end of such a period of use were 3.519 and 3.529, respectively. In the moist condition which is the condition in which it is attempted to maintain the sand, it contained from 1¾ to 2 per cent moisture dry basis. In Test 18 where the loam soil was used, it contained about 20 per cent moisture. After some preliminary trials, river sand has been selected as the abradant material for at least a phase of the work.

FIELD TESTING OBSERVATIONS

Along with laboratory work, some field work has been carried on. In this phase it is desired to obtain data on the comparative wear of commercial plow materials, also to study the work done by blacksmiths. Table 1 reports some representative hardness observations.

TABLE 1

Plowshare material	History	Hardness — Rockwell C (Mean of 10 or more readings) Body	Edge
Steel	Resharpened 3 times	25.5	17.1
Steel	Resharpened 3 times	29.4	22.8
Soft-center steel	Old—well worn	22.1	22.8
Soft-center steel	Worn out	83.5 (R_b)	83.0 (R_b)
Soft-center steel	New	60.0	60.0
Steel	New	28.2	28.2
Chilled cast iron	New	44.3	57.0

These results are a typical indication that soft-center steel shares are not hardened by the blacksmith in resharpening and that they are not harder than ordinary steel shares.

In plowing tests using 3-bottom plows and tractors, and transferring the shares to different positions, the results in Table 2 were obtained.

TABLE 2

Material	Steel	Soft-center steel	Chilled cast iron
6-hour test, Fort Hays (Kansas) Experiment Station			
Weight loss, pounds	0.03	0.05	0.04
Rank of edge loss	1 (most)	2	3 (least)
10-hour test, Manhattan, Kansas			
Weight loss, pounds	0.31	0.33	0.35
Rank of edge loss	1 (most)	2	3 (least)

In both of these tests the shares were worn to a point where they needed resharpening. In the work at Hays the extent of wear changed the share adjustments to different degrees. The bottom suck was removed quickly from the soft-center steel share. As this share was shifted to different positions, it was necessary to shift and add weights with it to produce satisfactory machine operation.

SHAPE OF CUTTING EDGE

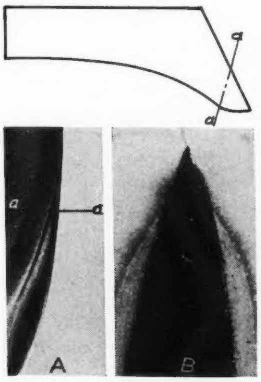

FIG. 7 PHOTOMACROGRAPH SHOWING CHARACTERISTIC MANNER OF WEARING OF SOFT-CENTER STEEL SHARES (4 DIAMETERS). (A) TOP VIEW OF SHARE NEAR POINT. (B) SECTION ON LINE *a-a*

Undoubtedly the cross section of the cutting edge is a matter of great importance. The shape of the cutting edge for best results is not now known. Therefore, some study has been given to edge characteristics from the standpoint of cross section, also to study the points at which wear takes place. In Fig. 6 are shown cross sections of new and worn edges of common share materials. These sections are obtained by plaster cast at a point 4 inches from the wing edge. The wearing characteristic of the soft-center steel may be noted.

It is observed that either the top hard ply or the bottom

(Continued on page 113)

Feed Processing in Relation to Animal Nutrition

By G. Bohstedt

THE SUBJECT of processing feed as discussed in this paper relates almost entirely to the grinding or chopping of roughages and grain. The subject of grinding hay or other roughage, or grain, has not by any means crystallized to set recommendations and practices. There are at present and there will no doubt continue to be factors operative that will raise the question as to whether or not it pays to grind a particular feed, how fine to grind, for what class of livestock, or for what age or condition of animal to grind, etc.

At the outset it may be well to discuss briefly definitions of grinding. Where roughages are involved, I prefer the term "chopping," or "cutting," rather than the term "grinding," which implies a rather fine division comparable to, let us say, moduli of fineness varying from 2 to 4, or therefore, comparable to the fineness of ordinary ground grain. Such fineness on the part of roughages is ordinarily required only in the case of alfalfa meal to be used in rations for pigs and poultry. Chopping or cutting, on the other hand, ordinarily means lengths of cut ranging from about 3/8 to 1 inch, whether applied to hay, straw, corn, or sorghum fodder. To be sure, in chopped or cut roughages there will always be some finely divided material and, of course, inevitably leafy and other material approximating the fineness of powder. Again where roughage is run through a hammer mill, one cannot well speak of length of cut so much as of chopped material in varying sizes, depending on the coarseness of screen used.

THE ADVANTAGES OF GRINDING

We recognize at least a half dozen advantages from grinding, using this term to cover all of the above considerations of fineness of division, as follows:

1 Grinding saves labor of chewing for an animal. This assistance of the natural grinding equipment of an animal by means of supplementary artificial teeth in machines, would seem to be especially helpful with coarse roughages. Just how the digestibility is affected may still be a question, as is indicated later.

2 Grinding saves whole grain from passing through the digestive tract of an animal and reappearing in the feces. When steers are fed heavily on shelled corn or ear corn, 10 per cent or more of the whole corn may pass through the animals undigested.

3 Grinding saves refuse. The coarser stems of hay, cornstalks, and sorghum fodder are frequently left in the mangers or the feed racks.

4 Grinding saves waste of hay and fodder. Fattening lambs especially are prone to pull long hay out of racks and tramp it under foot unless the racks are well designed. Fattening steers that are fed shock corn in the bundle in open bunks are apt to throw many cornstalks and incidentally many ears of corn on the ground. The ear corn, to be sure, is usually salvaged by pigs that are following the steers.

5 Grinding saves labor on the part of men. This is particularly obvious in the mechanization of hay harvesting and storing, especially where hay may be chopped into a wagon right out of the windrow and blown into a barn mow or other special hay storage.

6 Grinding saves storage space, reducing this to approximately one-half the space necessary for long hay.

In view of the above advantages from grinding or chopping, it may seem as if the advantages are overwhelming, and that all roughages and possibly all grain should be ground. But opposing this proposition is, first and foremost, the cost of machinery, power, and labor, and the established fact that digestion of roughages is not aided to any considerable degree by chopping or grinding. At times. actually a slightly lower digestibility has been reported for ground alfalfa hay than for coarsely chopped or long hay. Less regurgitation of previously swallowed boli has been reported with animals eating ground hay, which may mean that much of such fibrous feed has not been exposed as it should be to the bacterial action in the paunch of ruminants.

GROUND ALFALFA NOT MORE DIGESTIBLE

Neither has there been an advantage from the standpoint of digestibility where mixed grain and roughage have been fed to animals. To appreciate the practical significance of this mixing, it must be remembered that considerable shock corn and grain sorghum is run through feed grinders.

A further but seemingly minor objection to the grinding of hay is the increased dustiness which affects both man and beast. If the grinding operation is done in a closed room, as is frequently necessary in the wintertime, this is indeed very disagreeable work. It is to be hoped that our agricultural engineers will help solve the dust problem for the men as they grind the hay or grain, and for the animals, especially horses, at the time that they consume the hay. Where nowadays we hear talk even of air-conditioning buses and private automobiles, it would seem possible that the dust nuisance from grinding on the farm could be minimized by some sensible and practical device which would allow a minimum amount of dust in the air about the machine, and would also remove most of the dust from the chopped particles of hay.

As contrasted with dustiness of hay, we have the likelihood of moldiness of both hay and shock corn or grain sorghum fodder where these are processed at too high a moisture content. Shock corn, also called corn fodder, is usually higher in moisture content than will keep when chopped and stored in large quantities. Such cut or chopped material unless spread thin on a floor is extremely liable to heat and steam and become moldy, which may sicken livestock, particularly horses, to which it is fed. Where hay is harvested and chopped with a moisture content as high as 25 per cent, there is also apt to be discoloration and a development of mold and dust.

In experimental work chopping hay has frequently paid, merely considering the saving in the matter of refuse. A prime determining factor in the advisability of grinding or

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Author: Professor of animal husbandry, University of Wisconsin.

chopping coarse hay is the price as determined in turn by the relative scarcity of hay.

At the University of Wisconsin, chopping soybean hay saved 20 per cent of the feeding value with dairy cows. Obviously, running such hay through a hay cutter or ensilage cutter might pay where such hay costs $20 or more per ton, but where it might not pay, if it cost only $6 or $8 per ton. A similar saving of 20 per cent, more or less, might be expected in the case of coarse alfalfa hay or sweet clover hay. It has not proved economical to chop fine-stemmed, leafy hay for horses and ruminants.

The question of chopping or grinding corn fodder or grain sorghum fodder is still rather debatable. To process the grain contained in such forage satisfactorily, it would seem as if the grinding should be sufficiently fine to at least crack open every grain, whether sorghum or corn, for if this were not done it would seem necessary to have pigs following the animals in the feedlot or barn to salvage the undigested grain. But if every kernel of grain is cracked open, this practically assures satisfactory digestion of all grain, for it is recognized, I think, by most investigators that the most important step in the grinding of grain is the laying bare of the inside of each kernel, as is done in the cracking of corn or other grain. Any further grinding is relatively less important and may, as is indicated subsequently, be disadvantageous as it approaches the state of fineness of a meal or a flour.

Much corn fodder is simply run through an ensilage cutter and fed to steers in feed bunks where most of the corn is present as shelled corn, or sliced ear corn which, as stated, presents no problem where pigs are following the steers.

But in parts of the west, especially the southwest where grain sorghums are ground, this is frequently ground finely enough to grind also the grain. Furthermore, such ground sorghum fodder may be easily mixed with cottonseed cake or other protein supplements and may be fed with a high degree of safety and relative economy to cattle. There are thus circumstances under which it may pay to grind fodder rather fine. The cost of grinding is minimized through large-scale operations involving relatively little labor.

In recent years, especially where drought problems had to be met, a great deal of corn fodder or corn stover has been chopped and mixed with molasses. Aside from the problem of high moisture content of fodder and the likelihood of steaming and molding, there is the same problem that was pointed out previously relating to the mixing of ground grain and roughage. One need not expect such a mixture to result in a higher digestibility of the roughage. Such a mixture is warranted perhaps for making available and making palatable all possible roughage, and where the molasses that is to be used with it may sell at a lower price than corn or other grain, ton for ton. Whether bagged or baled, such fodder was found to be prone to heat and partially spoil.

In passing, I may refer to various experiments of processing roughage with warm water and the addition of so-called "predigesting" enzymes. At times the recommendations are to mix grain with such ground roughage and to steam, and in that way cook, the chopped roughage. To make a long story short, this system of processing has not, in several long-continued experiments, proved economical, for there was no actual predigestion of the fiber or cellulose in the roughage. There are no commercially available enzymes or convertors that digest fiber, and all that these processes accomplish is to cook or soften the material and permit a certain fermentation of easily attacked carbohydrates like the starches or the sugars, and in that way make fairly palatable low-grade roughage. On being eaten, such feed has not proved any more valuable on the dry matter basis than the original feed from which it was made. These processes merely involved a considerable amount of labor and material and did not come up to the claims made for them.

In the grinding of grain, we recognize that dairy cows should have all grain ground for them, whether corn or small grain. Fattening steers should have all small grain ground, but also corn if there are no hogs following. Pigs should have all small grain ground, but rarely does it pay to grind corn for them in the wintertime where new corn is being fed which has not yet dried down to the hardness that it frequently exhibits during the following summer. At such times it may pay to grind corn even for hogs. There are also frequently conditions of feeding that prompt the grinding of corn for pigs under various conditions, summer and winter, such as the desire to self-feed balanced rations or where certain ingredients are to be fed which may not be so palatable unless incorporated with the corn in the mixture.

Horses seldom need grains ground for them if such grains are at all suitable for horses. However, it is frequently a good practice to roll or to coarsely grind the grain that is to be fed to horses. Fattening lambs almost never need any grinding done for them because they have excellent grinders of their own.

Aged animals or those with poor teeth, or animals that are being worked hard or crowded to a high finish or to a high production, should be fed ground instead of whole grain. As in the case of hay, so with grain—the price level of feeds in relation to the cost of machinery and power and labor might decide whether it pays to grind or not.

In some experimental work with rolling oats for work horses at the Wisconsin Agricultural Experiment Station, it was found that rolling or crushing the oats improved their feeding value about 6 per cent. If oats are worth a cent a pound, or one dollar per hundredweight, therefore,

a 6-cent return is realized from rolling 100 pounds of oats. On the other hand, at 2 cents a pound for oats, as much as 12 cents per hundredweight is gained and may warrant the processing of oats in this fashion for work horses.

How fine should grain be ground is a perennial question. In our experimental work with corn and barley for pigs and dairy cows at the Wisconsin station, it was found that the fineness modulus of 3 came very close to being an all-around satisfactory fineness of division. Most people would designate this fineness as being a medium fineness, where, as one tests it by rubbing it between the thumb and the forefinger, it feels distinctly gritty rather than mealy or floury. In four experiments with dairy cows the animals preferred the medium finely ground barley to the finely ground barley. They also produced slightly more milk and gained slightly more in live weight on the medium as compared with the finely ground barley in their ration.

In the case of pigs that were fed corn and barley of varying fineness, it was concluded that in no case where grain needed to be ground did finer grinding prove the best. These findings are of even more significance in view of the extra cost of fine grinding.

The most recent question in the matter of grinding that we have put to pigs on experiment is how uniformly fine should corn and barley be ground for best results. One of the mills that was used for grinding produces a rather uniformly fine product. In contrast to this we mixed differently ground batches of corn or barley, which gave us an extremely variable division of fineness varying from a flour or a meal to a cracked condition. The average fineness, or therefore the fineness modulus, of the two contrasted ground grains was the same in each case. The two differently ground barleys and the two differently ground corns were fed dry to pigs in self-feeders and wet in troughs.

Where the pigs had abundant time to masticate their feed, as where it was fed dry in self-feeders, there was very little difference in the results as determined by rate of gain or feed required per unit increase in live weight. On the other hand, with some of the pigs that were fed the differently ground grains or rations wet in troughs and where the element of speed in eating as prompted by competition at the trough came into play, it seems from the results so far that there may be an advantage in having a fairly uniformly fine grain for them to eat. For they are apt to swallow rather hastily considerable of the cracked material which then may not be quite as thoroughly digested as the finer particles. This work is being continued at the present time for more significant results.

It is seen that this subject of feed processing in relation to animal nutrition is one that involves the cooperation of agricultural engineers and animal husbandmen, for the work of both plays a very important part.

On Lower Cost Materials for Farm Wiring

To the Editor:

THE DISCUSSION on the use of lower cost wiring materials for farm installations appearing in AGRICULTURAL ENGINEERING for January shows that many agricultural engineers having contact with farm wiring problems in different parts of the country are encountering similar problems and are thinking along the same lines.

I was especially interested in the letter of Mr. C. P. Wagner which appeared on page 27 of the January AGRICULTURAL ENGINEERING, wherein he described the efforts made by his company to reduce farm wiring costs in his territory where Underwriter's inspection does not prevail. I was also interested in his closing paragraph in which he urges that "material becoming available for these discussions should be studied to determine whether or not the writer is acquainted with field practices to the degree which will permit his speaking as an authority."

Since field practices differ widely between various sections of the country, it would be difficult for anyone to be fully conversant with field practices in all of them, and it is unlikely that any paper sufficiently general to include all sections would be sufficiently specific to offer any concrete and useful suggestions for any section.

In many eastern states the National Electrical Code is enforced by statewide inspection service covering both urban and rural districts, and the power companies in such states require Underwriter's approval on wiring installations before service connections will be made.

As I stated in my paper before the North Atlantic Section of the American Society of Agricultural Engineers at Ithaca, N. Y., last October (See AGRICULTURAL ENGINEERING for November 1935, vol. 16, no. 11, p. 431), the custom developed in this region for inspection departments to require that electrical contractors install rigid conduit or lead-covered armored cable in those farm buildings where moisture or ammonia fumes were present, the mistaken thought being that these methods provided the maximum protection against corrosion.

We have never attempted to disparage the use of knob-and-tube wiring, but consider it an excellent system. However, in New York state knob-and-tube wiring is no longer used in farm house wiring due to the larger number of holes to be bored in beams and joists, per circuit, than when cable assemblies are used, and to the necessity of inserting the wire in "loom" when it is to be fished through partitions. At prevailing labor and material prices, armored cable displaced knob-and-tube work some time ago for house wiring, with the result that contractors no longer stock the necessary materials and consequently do not use it as a barn wiring method. They have become accustomed to armored cable installations, hence it was logical to switch them to non-metallic cable rather than to try to educate them to a system to which they are largely unaccustomed. In barns, moreover, knob-and-tube or open wiring needs as much, if not more, mechanical protection than non-metallic sheathed cable. In No. 8 and larger sizes the non-metallic cable requires less protection.

Inspectors have customarily required metal-clad wiring in barns and most farmhouse basements until the 1933 National Electrical Code permitted non-metallic sheathed cable in damp locations. It is rapidly displacing all other farm wiring methods in most parts of New York state and many adjacent areas. The standard specifications for farm wiring now in use by many power companies in this state require the use of non-metallic sheathed cable and non-metallic service entrance cables throughout the entire farm. Should the protected neutral concentric cable discussed by Messrs. Murray and Larson in AGRICULTURAL ENGINEERING for January 1935 be approved there is good reason to expect that this type of cable eventually will attain a price 25 to 40 per cent below standard non- *(Continued on page 119)*

Burr Mill Design and Performance

By H. D. Bruhn

THE OBJECT of the investigation described in this paper was to determine some of the fundamental principles involved in the design and performance of the burr type feed mill, and the relation of the numerous factors to each other. Up to the present time, the following factors have been investigated:

1 Effect of mill speed upon grinding efficiency
2 Effect of mill speed on fineness
3 Effect of rate of grinding on efficiency
4 Effect of rate of grinding on fineness
5 Effect of fineness of grinding on power required
6 Effect of burr design on efficiency

During a period of three years, 1932 to 1935, over 600 tests have been run and complete data taken. The work has covered only the smaller type mill, but the anticipated program is to be more comprehensive and is to cover not only larger mills but also a study of the actual process of grinding that takes place between the burrs. Most of the factors applying to small mills will probably apply in a general way to larger mills. The equipment used in these tests consisted of a 5-hp electric cradle dynamometer with a nominal speed of 1200 rpm; a synchronized recorder and control consisting of electric counters for both the dynamometer and the mill, electrically controlled stop watch, and a control for a magnetic ground grain valve; a variable-speed, auger-feeding device; a Ro-Tap shaker for fineness modulus determinations; a Brown-Duvel moisture determination apparatus; a special mill built by the C. S. Bell Company, Hillsboro, Ohio; numerous pieces of small equipment such as thermometers, belt tension scales, grain weighing scale, and so forth. Six pairs of burrs (Fig. 15) 5½ and 6 inches in diameter were used. The mill used for the greater part of the test work was a special machine modified from the regular No. 50 Bell design. The bearing hub to the rear of the mill was extended and increased in size to take a pair of Hyatt roller bearings. The rigid burr mounting surface was machined normal to the bearing hub. Two shafts and revolving burr carriers were used, one which allowed the revolving burr to float, and the other which carried a rigid burr mounting and was machined so that the revolving burr was at all times normal to the shaft. All burrs were ground so that the mounting surface and grinding surface were parallel. A 20-pitch-thread, burr-clearance adjustment screw was used with a calibrated disk so that the burr clearance could be set to 0.001 inch. The burrs operate at a fixed clearance; a light spring holds them at the maximum clearance allowed by the adjustment screw.

The procedure in this test work was such that at any one time, all, except one known variable, were held constant; thus the effect of this one variable could be studied. A brief description of running a test seems in order here to explain the procedure. After the preliminary adjustments were made, the idling load of the mill was determined. Then the feeding mechanism was started, and when all was balanced and was running properly, the test was started by closing a switch on the synchronized recorder and control mechanism. This started an electric counter on the dynamometer, another on the mill, and also started the stop watch and set the magnetic ground-grain valve so that the ground grain would flow into the weighing tank

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Author: Research engineer, Wisconsin Agricultural Engineering Experiment Station.

NOTE: The author desires to acknowledge the assistance, in this work, of G. J. Burkhart, H. W. Gerlach, G. J. Graney, M. G. Huber, S. J. Otis, R. R. Poyner, and Wm. Southworth.

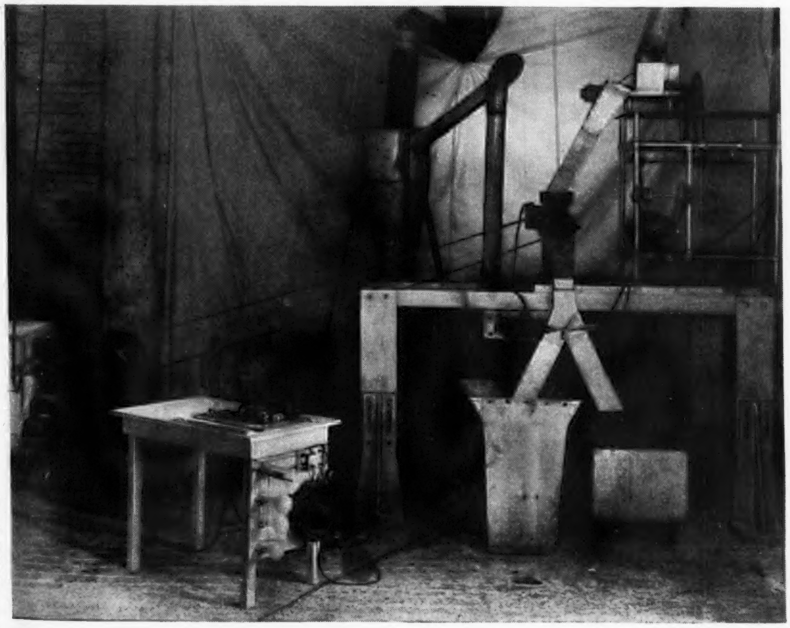


FIG. 1 THE GRINDING INSTALLATION

To the left, the 5-hp electric cradle dynamometer. Next to the dynamometer is the synchronized control and recording mechanism mounted on the table. On the side of the table is the rheostat control for the variable-speed, direct-current motor used on the feeding mechanism which is located at the upper righthand corner of the picture. To the left of the feeding mechanism is the test mill; directly in back of the test mill is the electric contactor for the mill revolution counter. Below the mill is the magnetically controlled ground-grain valve which directed the grain either to the waste hopper on the left or the weighing hopper mounted on a scale to the right

mounted on a scale. The tests were of six-minute duration. During the test, a representative sample of the ground grain was taken for fineness modulus determinations, and dynamometer scale readings were taken every half minute. In the majority of tests, the load remained practically constant as indicated by the dynamometer scale. At the end of the test, the total weight and temperature of the ground grain were determined. The electric counters were read, the test weight of the remaining unground grain determined, and the sample for a moisture determination taken.

At the start of the 1934 and 1935 term, a completely enclosed 900-bushel bin of oats was set aside for this work so as to have a uniform grain at all times. The grain had been cleaned and thoroughly mixed before placing in the bin, and was again cleaned before it was used for the test work. A few tests were run on corn and barley to check the performance against data from tests on other mills. The moisture determinations were made with the conventional Brown-Duvel moisture determination equipment. The modulus determinations were made with the standard Tyler screen series and the Ro-Tap shaker. Calculations were made both on the basis of net horsepower delivered to the grinding chamber and gross horsepower delivered to the driving belt of the mill. For this part of the work, net horsepower to the grinding chamber is used, as it eliminates such variables as belt windage and friction and seems to be the logical method for basic studies.

RESULTS

Fig. 3 shows the net horsepower-hours per hundredweight required to grind grain to different moduli at speeds ranging from 200 to 3400 rpm. The nominal rate of grinding for this series of tests was one-half horsepower. That is, one-half horsepower was being delivered to the grinding chamber of the mill at all times during the tests. This chart shows that when the mill was operated at 200 rpm, the power required per 100 pounds of grain ground was quite high, namely, 0.6 hp-hr per hundredweight for a modulus of 2.5, ranging down to approximately 0.2 hp-hr per hundredweight for a modulus of 3.9. Next below the 200-rpm curve is the 400-rpm curve; thus by increasing the speed from 200 rpm to 400 rpm, yet delivering the same horsepower to the grinding burrs, the efficiency is increased considerably. The curves showing the power required at 600, 1000, 1400, 1800, and 2200 rpm are quite close together, yet there is a definite tendency for the higher speeds to require less power than the lower speeds for grinding to the same fineness. At the extreme lower edge of the group of curves, the 3400-rpm curve stands out, showing that the grinding efficiency is highest at 3400 rpm, that is, highest of this group of speeds.

Fig. 4 shows the same relationship as was shown in Fig. 3, when 2 hp are being delivered to the grinding chamber. The spread here, however, is larger, showing that for higher rates of grinding, increasing the speed will increase the efficiency of the mill more than the comparable increase at the lower rates of grinding. This chart starts at 400 rpm. The reason was that the test mill would not take enough grain at the speed of 200 rpm to develop a load of 2 hp, and, even at 400 rpm, it would not take enough grain to develop a 2-hp load above a modulus of about 2.6.

Fig. 5 shows the same relation as Figs. 3 and 4 when 3 hp are being delivered to the grinding chamber. The lowest speed at which the mill would take enough grain to develop a 3-hp load was 1000 rpm; thus, the slowest speed shown on this chart is 1000 rpm. Here the curves stand out very distinctly. The 1000-rpm curve at the top, being the least efficient, and the 3400-rpm curve being at the bottom

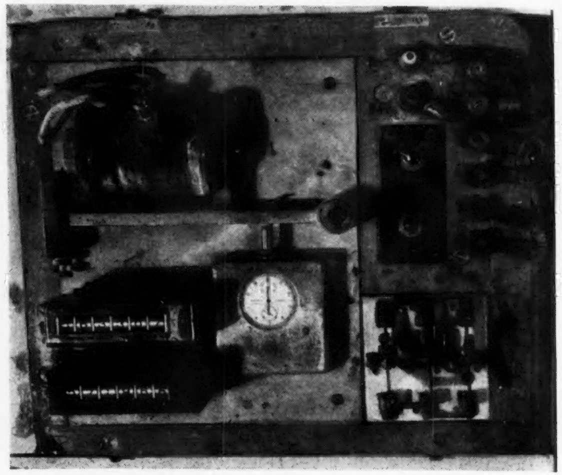


FIG. 2 THE SYNCHRONIZED CONTROL AND RECORDER SHOWING THE ELECTRIC COUNTERS, THE STOP WATCH, AND THE CONTROL SWITCH

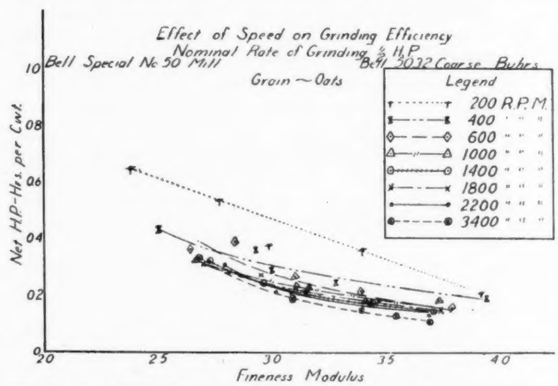


FIG. 3 THE EFFECT OF SPEED OF THE MILL ON THE POWER REQUIRED PER 100 POUNDS OF GRAIN GROUND TO VARIOUS DEGREES OF FINENESS WHEN THE NOMINAL RATE OF GRINDING IS ½ HP

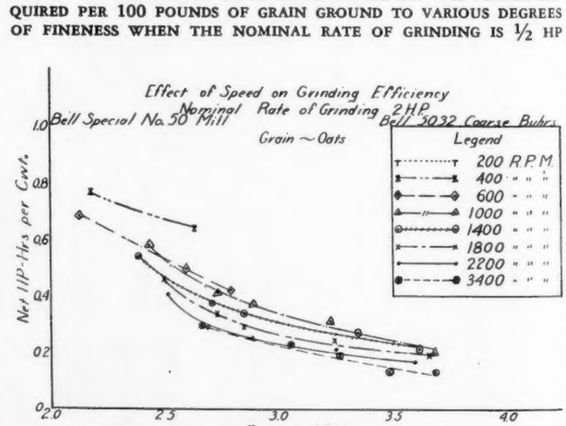


FIG. 4 THE EFFECT OF SPEED OF THE MILL ON THE POWER REQUIRED PER 100 POUNDS OF GRAIN GROUND TO VARIOUS DEGREES OF FINENESS WHEN THE NOMINAL RATE OF GRINDING IS 2 HP

again shows that at this horsepower the speed of 3400 rpm is considerably more efficient for grinding than the other speeds.

Fig. 6 shows the material on Fig. 4 presented in a different manner. The ordinate of this graph is net horse-

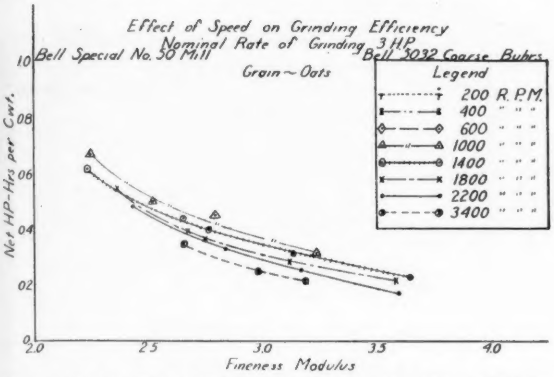


FIG. 5 THE EFFECT OF SPEED OF THE MILL ON THE POWER REQUIRED PER 100 POUNDS OF GRAIN GROUND TO VARIOUS DEGREES OF FINENESS WHEN THE NOMINAL RATE OF GRINDING IS 3 HP

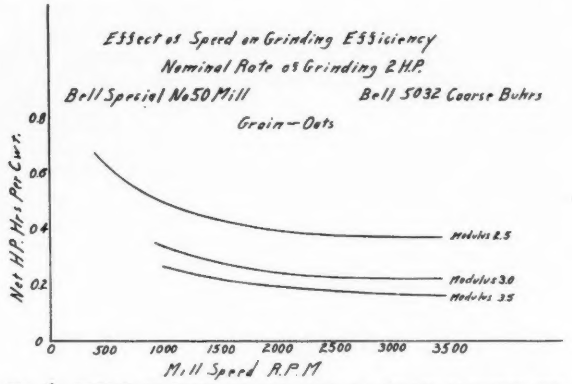


FIG. 6 EFFECT OF SPEED OF THE MILL ON POWER REQUIRED PER 100 POUNDS OF GRAIN GROUND TO A GIVEN FINENESS MODULUS OF 2.5, 3.0 OR 3.5

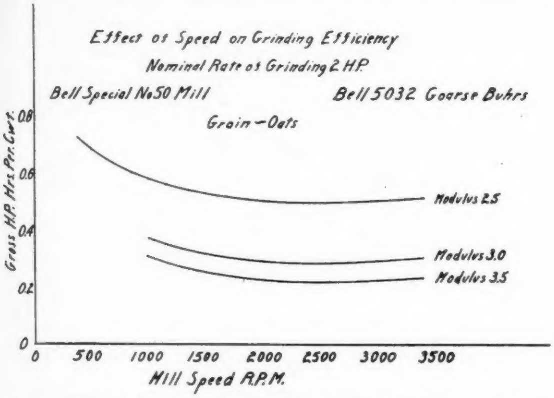


FIG. 7 EFFECT OF SPEED OF THE MILL ON GROSS POWER REQUIRED PER 100 POUNDS OF GRAIN GROUND TO A GIVEN FINENESS MODULUS OF 2.5, 3.0, OR 3.5

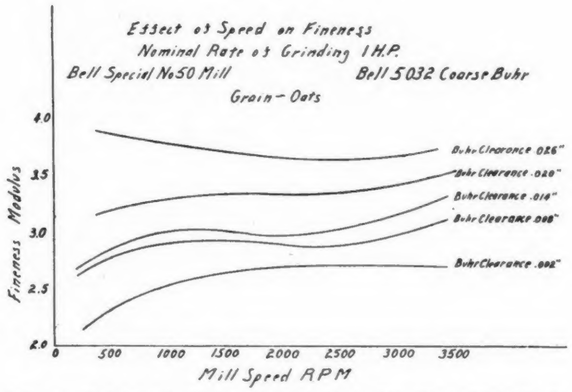


FIG. 8 EFFECT OF SPEED OF THE MILL ON THE FINENESS TO WHICH THE GRAIN IS GROUND AT A GIVEN BURR CLEARANCE FOR A NOMINAL RATE OF GRINDING OF 1 HP

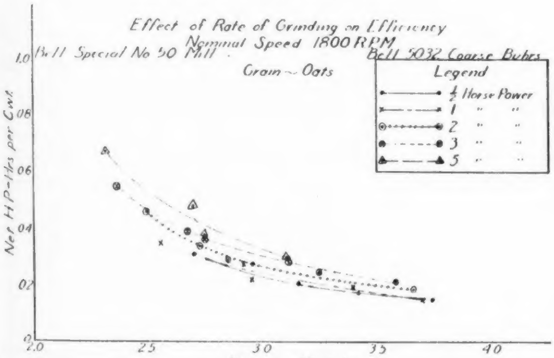


FIG. 9 EFFECT OF RATE OF GRINDING ON POWER REQUIRED PER 100 POUNDS OF GRAIN GROUND TO VARIOUS DEGREES OF FINENESS AT A NOMINAL SPEED OF 1800 RPM

power-hours per hundredweight as before, but the abscissa is mill speed in revolutions per minute. Each curve represents a constant modulus, the upper curve as labeled being a modulus of 2.5; the next, a modulus of 3.0; and the lower curve, a modulus of 3.5.

These curves show three things: First, the fact that for any given modulus the power required to grind 100 pounds of grain decreases as the speed of the mill increases. Second, they show that although the efficiency in terms of net horsepower increase up to 3400 rpm, the increases are smaller above 2000 rpm. Third, they show the difference in power required to grind grain to different degrees of fineness. For instance, at 2000 rpm, the power required to grind 100 pounds of oats to a modulus of 2.5 is about 0.4 hp-hr, while to grind the same grain to a modulus of 3.5 is practically 0.2 hp-hr; thus this series of charts shows that at higher speeds a burr mill will grind considerably more efficiently than at low speeds, and that grinding to a fine degree takes a great deal more power than medium or coarse grinding.

Fig. 7 corresponds to Fig. 6, except that it is on the basis of gross power delivered to the driving belt of the mill instead of net power delivered to the grinding chamber. This group of curves shows that the increase in friction load begins to more than offset the gain in grinding efficiency of a 5½-inch burr above a speed of 2400 rpm. when grinding at a nominal rate of 2 hp. Throughout the speed range from 2000 to 3000 rpm, the power required per hundredweight of grain ground is of approximately the same magnitude. For practical reasons it is desirable to use the lowest speed of the range, or a speed even slightly lower. Very little is to be gained in grinding efficiency by operating above a speed obtained by direct connecting the mill to a 1750-rpm motor.

Fig. 8 shows the effect of speed on fineness. Here again the ordinate represents fineness modulus, and the abscissa represents mill speed in revolutions per minute. There seems to be no simple relation between mill speeds and the fineness to which the mill will grind for a given burr clear-

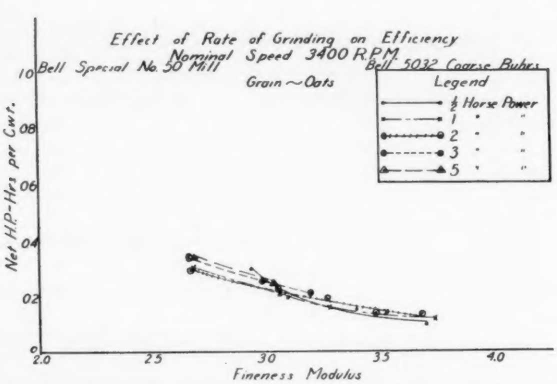


FIG. 10 EFFECT OF RATE OF GRINDING ON POWER REQUIRED PER 100 POUNDS OF GRAIN GROUND TO VARIOUS DEGREES OF FINENESS AT A NOMINAL SPEED OF 3400 RPM

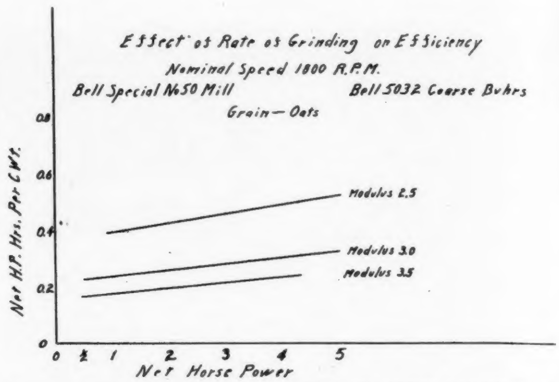


FIG. 11 EFFECT OF RATE OF GRINDING ON POWER REQUIRED PER 100 POUNDS OF GRAIN GROUND TO A FINENESS MODULUS OF 2.5, 3.0, OR 3.5 AT A NOMINAL SPEED OF 1800 RPM

ance at constant horsepower. This is undoubtedly due to the fact that a second variable, namely, the relative rate of grinding, comes into effect.

Fig. 9 shows the effect of rate of grinding on efficiency. On the ordinate as before is net horsepower-hours per hundredweight, and on the abscissa, the fineness modulus. In this group of curves, the one-half horsepower rate of grinding curve is quite definitely below the higher rates; thus it shows that the grinding efficiency at one-half horsepower was much higher than for the greater rates of grinding. As the rate increases to 1 hp, the efficiency decreases. The same holds true for 2 and 3 hp, and the 5-hp rate is very definitely the least efficient of this group, shown by the fact that the curve is to the top of the group on the chart. This chart was made for a nominal speed of 1800 rpm of the mill.

Fig. 10 corresponds to Fig. 9, but it is for a nominal speed of 3400 rpm of the mill. The fact that all the curves on this chart lie quite closely together shows that the effect of rate of grinding on efficiency is not nearly so pronounced at 3400 rpm as it is at 1800 rpm.

Fig. 11 shows the material of Fig. 9 presented in a different manner. In this chart, the ordinate is again net horsepower-hours per hundredweight, but the abscissa is net horsepower delivered to the grinding chamber of the mill. The fact that these lines all have an upward slope toward the right end shows that for a given speed the most efficient grinding is done at the lowest horsepower. For instance, a modulus of 2.5 at 1-hp rate of grinding will require 0.4 hp-hr per 100 pounds of oats ground, while at 5-hp rate of grinding, the power requirement will be in the neighborhood of 0.55 hp-hr per hundredweight. The same relation is shown to hold true for moduli of 3.0 and 3.5. The vertical spacing of these lines shows the difference in power required per 100 pounds of grain ground. For example, at 3 hp, the power required to grind 100 pounds of grain to a modulus of 2.5 is 0.468 hp-hr per hundredweight, while to grind the same grain to a modulus of 3.5, the power is 0.22 net hp-hr per hundredweight.

Fig. 12 shows the effect of rate of grinding on fineness for a nominal speed of 1800 rpm. On this chart, the ordinate is fineness modulus ranging from 2 to 4, and the abscissa is net horsepower delivered to the grinding chamber. These curves show that, as the rate of grinding increases for a definite speed, the grinding becomes finer for a given burr clearance. For example, at a rate of grinding of ½ hp and a burr clearance of 0.02 inch, the modulus is about 3.4; with all things remaining the same, excepting that the rate of feeding is increased so that a 5-hp load is

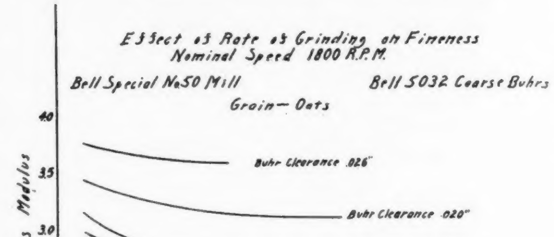


FIG. 12 EFFECT OF RATE OF GRINDING ON FINENESS TO WHICH GRAIN IS GROUND AT A GIVEN BURR CLEARANCE AT A NOMINAL SPEED OF 1800 RPM

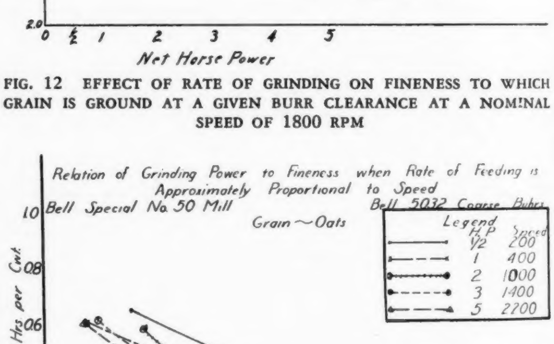


FIG. 13 RELATION OF GRINDING POWER PER 100 POUNDS OF GRAIN GROUND TO VARIOUS DEGREES OF FINENESS WHEN THE RATE OF GRINDING IS APPROXIMATELY PROPORTIONAL TO SPEED. RANGE ½ HP AT 200 RPM TO 5 HP AT 2200 RPM

developed, the fineness modulus becoming 3.1. The same relation is shown by the other curves to hold true for all the different burr clearances at which the mill was run.

Fig. 13 shows the relation of power required for grinding to fineness, when the rate of feeding is approximately proportional to the speed of the mill. The data for this chart was taken from the regular test series so the rate of feeding and speed are not exactly proportional at all times, but, with this in mind, and the information gained from

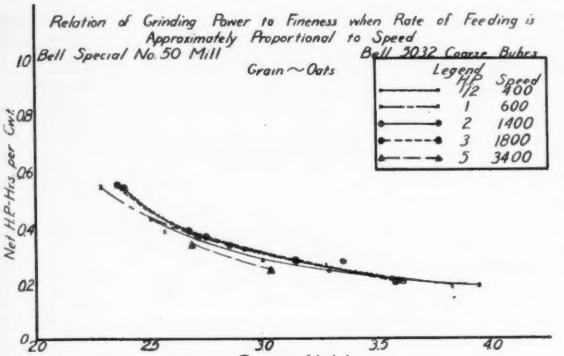


FIG. 14 RELATION OF GRINDING POWER PER 100 POUNDS OF GRAIN GROUND TO VARIOUS DEGREES OF FINENESS WHEN THE RATE OF GRINDING IS APPROXIMATELY PROPORTIONAL TO SPEED. RANGE ½ AT 400 RPM TO 5 HP AT 3400 RPM

the previously discussed curves, it is possible to gain further information from these curves.

The ½ hp at 200 rpm series stands out considerably above the other tests. In other words, this shows that at ½ hp and 200 rpm, the efficiency was much lower than for the other run. This can be explained by the fact that, in the neighborhood of 200 rpm, the efficiency of the burr mill decreases very rapidly, out of all proportion to the decrease in speed. The 1, 2, and 3 hp curves are grouped quite closely—in fact, they overlap somewhat. The 5-hp curve is at the bottom of the series; that is, the grinding efficiency is highest.

Fig. 14 is similar to Fig. 13, with the exception that the speeds are higher. Starting with a base speed at ½ hp of 400 rpm in this group, instead of 200 rpm as in Fig. 13, the curves for the different rates of grinding and speeds, with the exception of the 5-hp, 3400-rpm curve, practically coincide, thus showing that high efficiency can be maintained in small burrs for the greater rates of grinding by increasing the speeds proportional to the increase in rate of grinding.

Fig. 15 shows a brief study of relation of burr design to grinding efficiency. The ordinate of the curve is again net horsepower-hours per hundredweight required for grinding, and the abscissa, fineness modulus. The upper curve of the group represents the Bell No. 50 extra fine burr. This is a radial type burr, and, as shown by the position of the curve, it is very inefficient for medium and coarse grinding of oats. The design of this burr causes it to have more of

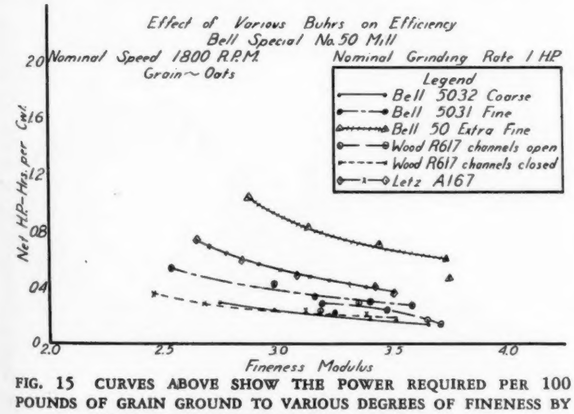
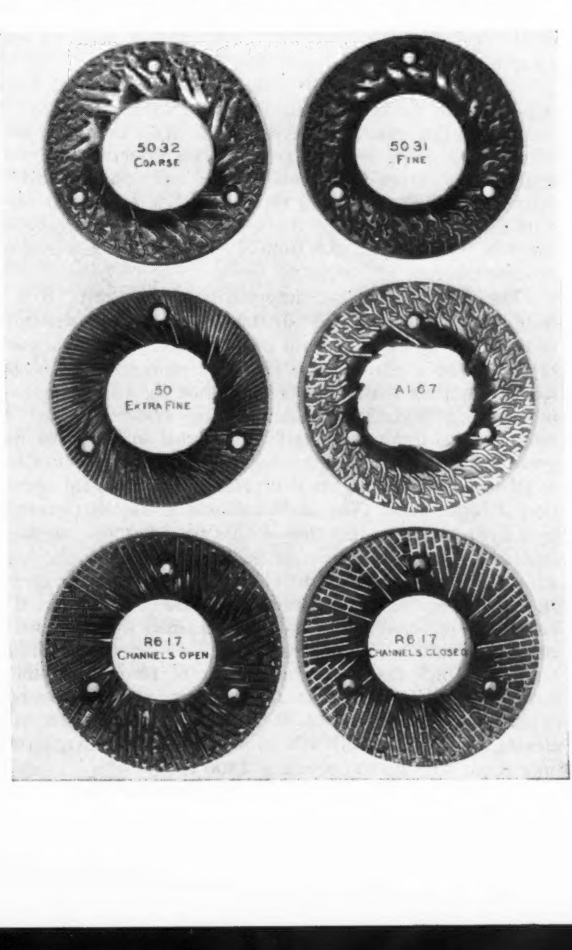


FIG. 15 CURVES ABOVE SHOW THE POWER REQUIRED PER 100 POUNDS OF GRAIN GROUND TO VARIOUS DEGREES OF FINENESS BY BURRS OF NUMEROUS DESIGN SHOWN AT RIGHT

a crushing action than a cutting action. This burr causes the ground grain to have a flaky appearance. The second curve from the top represents the Letz No. A167 burr. This is a burr type that commonly goes by the name of "crowfoot." The feeders at the inner part of this burr are of two different sizes. There are six smaller feeders and two larger feeders. To place this burr in the mill, it was necessary to grind some of the ends off the larger feeders. The indications are from the study so far that any crowding of the burr tends toward inefficient grinding. It would seem reasonable to believe that the two larger feeders would tend to cause a crowding of the grain directly in front of them. This probably accounts in part for the inefficiency. This burr cuts the oat hulls particularly well, however.

The curve third from the top represents the Bell No. 5031 fine burr. This burr resembles the No. 5032 coarse burr very much, excepting that there are more of the projections, that is, grinding projections on the burr. This burr also cuts the oat hulls well, and was considerably more efficient than the two previously discussed burrs.

The Wood No. R617 burr is a double burr; that is, either side is intended to be used for grinding purposes. One side of the pair of burrs was ground down to a point such that any grain passing out over the burr had to pass over a cutting edge. The other side of the burr was left in its original condition. In this condition, the channels were only partially blocked, and it was possible for some grain to pass over the blocks. As is shown by the chart, the burrs, when ground so that the channels were completely blocked, were slightly more efficient than when the channels were left partially open. The Bell No. 5032 coarse burr represented by the dotted line at the extreme bottom of the chart was the most efficient for the medium and coarser grinding. There is very little difference, however, between the efficiency of this burr and the Wood No. R617



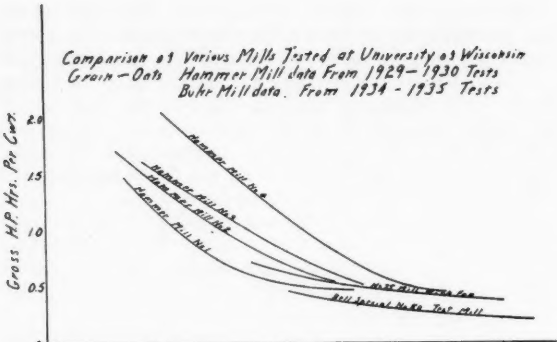


FIG. 16 CURVES SHOWING THE TOTAL OPERATING POWER PER 100 POUNDS OF GRAIN GROUND TO VARIOUS DEGREES OF FINENESS BY NUMEROUS MILLS TESTED

burr with channels closed. The Bell No. 5032 coarse burr is the burr which was used for the majority of the test work.

Fig. 16 shows a comparison of the performance of the small burr mills, and hammer mills tested previously. Hammer mill No. 4 was a mill built to operate at 7½ hp, but for the test work it was operated at 5 hp. Thus the efficiency was quite low. Hammer mills Nos. 1, 2, and 3, however, were operated at their specified ratings. The Bell Special No. 50 test mill equipped with a No. 5032 coarse burr is shown by this chart to be more efficient than any of the hammer mills, especially in the medium and coarser grinding. For the finer grinding, the power required per 100 pounds of grain ground will increase quite rapidly; however, as discussed by Professor Bohstedt (in his paper appearing elsewhere in this issue), exceptionally fine grinding is not desirable, so no effort has been made to obtain a burr to grind oats to a modulus of less than 2.5.

The No. 75 burr mill is shown to be somewhat more efficient than the Nos. 2 and 3 hammer mills. The No. 75 mill has a fan attached directly to the main shaft and will elevate the grain as it is ground. The efficiency of this mill can be increased considerably by equipping it with a burr of the Bell No. 5032 type, as only a little over one-half the power shown by the spread between the curve of the No. 75 mill and the Bell No. 50 mill is required to operate the fan.

Fig. 17 is one of the outgrowths of the study. It is a mill design that embodies all the features found desirable in the study on efficiency and performance. The main shaft is carried on a pair of anti-friction bearings. This is desirable from the standpoint of durability, light running, and maintaining perfect alignment. The revolving burr is mounted rigidly on the shaft and normal to it so that the grinding surfaces of the revolving and stationary burrs are at all times parallel. This is necessary for successful operation at high speed. The burrs are held at the set clearance by a light spring so that they do not tend to move together and strike when no grain is passing between them. An adjustment screw is used to obtain the desired burr clearance. A safety release has been incorporated to protect the burrs in case foreign material such as small stones or nails enter the mill. An agitator above a V-notched, feed-regulating slide makes a uniform rate of feeding possible. Since the mill is to operate at a high speed, it is possible to mount a fan directly on the main shaft. This fan will elevate all that the mill will grind efficiently and requires only about 0.08 hp to operate at 1800 rpm.

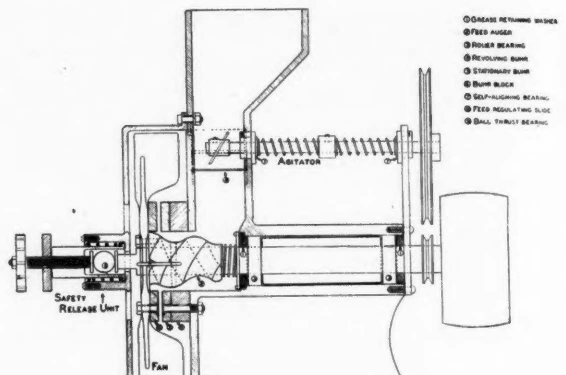


FIG. 17 THE MILL DESIGN THAT HAS BEEN ONE OF THE OUTGROWTHS OF THE WISCONSIN STUDIES ON BURR MILL DESIGN AND PERFORMANCE

By incorporating these features the mill can be set up to operate without an attendant, thus reducing not only the power cost of grinding feed by its efficient operation but also the labor cost.

Fig. 18 shows two pairs of burrs. The pair on the left is as it came from the factory, while the pair on the right was used in the test work on the No. 75 mill, and was then used to grind 36,000 pounds of barley. These burrs are far from worn out, but definite wear is shown where the feeders join the main part of the burr. It should be possible to improve the efficiency of this burr by a modification of the design.

CONCLUSIONS

To obtain high grinding efficiency in the small burr type mills, the speed must be high and the rate of feeding must be regulated to eliminate crowding of the burrs. Therefore, it is necessary that the mill be equipped with a feeding de-

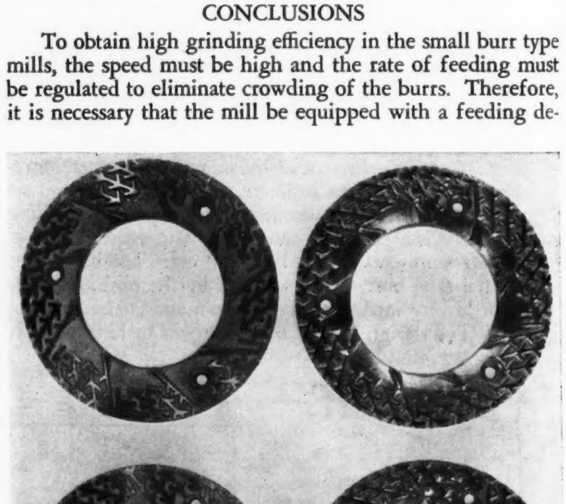


FIG. 18 TWO PAIRS OF BURRS—(LEFT) AS THEY CAME FROM FACTORY, (RIGHT) AFTER SOME USE

vice which will continue to feed the mill uniformly at any desired rate.

When high speeds are used, it is necessary to use rigid burr mountings, good bearings (preferably anti-friction), and fixed burr clearance to eliminate vibration and to prolong the life of the burrs and the mill. It is also essential that the mill be equipped with a safety release to obviate damage due to foreign material in the grain.

The permissible rate of feeding the mill is almost directly proportional to the speed. Therefore, when the most efficient rate of grinding at any speed is found for a particular burr, it is possible to predict very closely the most desirable rate of grinding for any other speed or to predict the proper speed for any other rate of grinding desired.

A burr mill, if operated at fairly constant speed and rate of feeding, will grind to nearly the same fineness modulus for a long period of time at a given burr clearance.

Burr design is a very important factor in the performance of a mill.

It has been demonstrated that in the small size the burr mill will perform equally as well as the hammer mill.

Discussion by M. E. Hamilton

IT IS interesting to note that this study of burr mills finds them to be the most satisfactory for unattended grinding units.

The experience in the past with this type of mill has been that (1) it tends to heat the grain, especially when the burrs are dull; (2) foreign material destroys the plates and frequently breaks the mill; (3) the power requirement increases rapidly as the dullness of the burrs becomes apparent; (4) and they will not handle roughage.

To uphold these contentions, I wish to refer to a test made at the University of Wisconsin (ASAE Transactions, vol. 24, 1930) in which it is stated that "they did not stand up in service; the burrs dulled quickly, becoming very inefficient; and foreign material in the grain was disastrous to the mill, in one case resulting in the ruining a new leather belt.

"These mills were unsatisfactory with an attendant present, and it is obvious that still greater trouble would be encountered if the mills were automatic, which is almost necessary to be practical, due to the comparatively slow rate of grinding."

By studying the design of this new burr mill, I find that an attempt has been made to remove some of the defects of older mills of this type. A more efficient type of burr was used; however, very little is mentioned about its wearing qualities.

Then an automatic safety release has been provided to allow the burrs to separate if foreign material in the grain, such as bolts, nails, etc., should pass between them. The burrs can separate to allow a clearance of about 3/8 inch. This amount of clearance would perhaps allow some of the smaller pieces to pass through, but it would provide no protection if there were larger pieces in the grain. Then it is very doubtful if this safety release would do any good at all, because of the high rate of speed at which the burrs are operated.

Now in the same report from the University of Wisconsin, it is stated, "We believe that the hammer type feed mill, due to its inherent principles of operation, has important advantages over burr mills for automatic electric operation as follows:

"1 They are not damaged and do not use much power when running empty.

"2 Foreign material going through the mill is not apt to do much damage to the mill, or to the animal which may take it in later. Nails, for example, are chewed up into more or less round pellets, which are certainly not as likely to pierce the intestines as the sharp, needle-like pieces that sometimes come out of a burr mill.

"3 The mills maintain their original efficiency over long periods of time.

"4 The high speeds adapt them readily to the electric motor.

"5 They are proving to be very durable."

To further substantiate my contentions, I refer to Kansas State College Bulletin No. 27, in which it states that "the hammer mill is perhaps best adapted to automatic operation, because it is not injured by running empty nor by small particles of such foreign matter as nails and bolts." And in Ohio State University Bulletin No. 490, it says that "only on very coarse grinding does the burr mill exceed the hammer mill in efficiency."

Thus it seems that this new burr mill is designed to be an improvement upon the present ones which are now in use. But it has not been proven that it possesses more durability or freedom from breakage, so we should have definite proof of these items before we accept them as facts.

In many instances it is desirable to have a mill that is capable of grinding roughage. Though there is a difference of opinion as to whether it pays to grind roughage, the fact remains that many thousands of tons of hay, corn fodder, and sorghums are ground each year and many hammer mills are sold for that purpose only. Many feeders have shown cheaper feeding costs when ground roughage was used as a supplement to grain, and in many cases during the drouth of 1934 the grinding of roughage by some farmers allowed them to make the feed last longer than it would if it had not been ground.

It is perhaps true that an ideal installation of a small mill (either hammer or burr) and an electric motor would produce ground feed at a very low cost.

However, most farmers now have tractors that have the necessary amount of power to operate the average size of hammer mill, which will grind grain and roughage to the degree of fineness desired. The cost of a hammer mill of this type is less than the combined cost of a smaller mill and an electric motor. Then the most economical course is to use a mill of this size and utilize the tractor power. Thus the utility of the tractor is increased and the time required for grinding is decreased.

If the mill is set so that it can be fed from an overhead bin, there is no reason why it will not operate just as well unattended with tractor power as with an electric motor.

Author: Engineer, J. I. Case Co.

Discussion by E. A. Silver

IN THE preparation of feed for animals we have two rather distinct processes. The first may be termed the mechanical process which requires such operations as grinding, cutting, or crushing, and all usually require power through mechanical means. If these operations are manipulated properly the chemical composition of the feed is not changed.

The second process may be termed the biological pro-

Author: Research agricultural engineer, Ohio State University. Mem. ASAE.

cess, because it is accomplished by the animal itself and may include, depending on the animal in question, one or all of the following steps: (1) Mastication or chewing, (2) softening by liquids within the stomach or mouth, (3) rolling and mixing within the stomach, and (4) rumination or rechewing.

Through each of these steps the food has been changed chemically as well as physically before the useful part of the food, for body absorption, is separated from the waste matter.

For many years feeding trials with livestock have set the standard for best feeding practices. They have been conducted with practically all kinds and combinations of feeds and with various forms of mechanical processing. They have pointed out specifically the need of mechanical processing on some feeds, especially in the case of an animal with poor teeth and for the hard working dairy cow. They have also indicated on some feeds that better results can be obtained, if the animal is allowed to reach a limit of efficiency on its own method of processing before any mechanical processing is done.

Mechanical processing, therefore, may have reached a stage where it may be a detriment to efficient biological transformation of energy of food into useful work. In other words, we have not determined the proper balance or relationship that should exist between the kind and amount of mechanical processing done and that left for the animal itself.

This immediately involves the following considerations:

1 What feeds should be mechanically processed and for what classes of livestock
2 Fineness to which to grind these feeds
3 The effect of very finely pulverized material
4 A thorough study of the physiological and biological actions taking place within the stomach of the animal.

AN ORGANIZED PROGRAM OF RESEARCH ON THE PROCESSING OF FEED FOR ANIMALS

In making a logical approach to this whole problem, I am convinced that the starting point is with the chemical and physical transformation of food into energy requirements for the body by means of internal manipulation. A thorough study on the physiological viewpoint dealing with the organs and parts within the stomach of the animal, together with a chemical and physical analysis of the food as it is acted upon by the various organs within the stomach, will be beneficial for further feeding trials.

The ASAE Committee on Feed Mill Ratings is endeavoring to work out an organized program of research on the processing of feeds for animals. To date several of the agricultural experiment stations have contributed toward this end. Considerable work has been done at the University of Wisconsin, the results of which Professor Bohstedt has just given you. We find similar studies have been conducted at Purdue and other stations as well.

In order to arrive at a satisfactory solution of this whole problem, it requires the cooperation of several departments, viz., agricultural engineering, animal husbandry, animal nutrition, veterinary medicine, and animal physiology. At the Ohio station we have started a project for the purpose of studying the chemical and physical transformation of food into energy requirements for the body by means of internal manipulation. This project as set up has the following cooperators: Agricultural engineering, animal husbandry, animal nutrition, and veterinary medicine. Four beef steers are used for the work, and they ranged in age from six to eighteen months at the beginning of the test.

The study as projected requires direct visual inspection and a means for securing specimens of the contained ingesta within the stomach of the animal. The logical approach, therefore, is by way of the gastric fistula which necessitates making a vertical incision through the body and stomach walls of the animal and at a point near the rear left flank region of the body. A removable wooden or pneumatic rubber plug is used to close the opening.

The first part of the project includes experiments with alfalfa hay exclusively. This material is mechanically processed into various forms, such as coarse cut, fine cut, and ground. All of these preparations are run in conjunction with a series of tests on whole hay.

The degree of mastication on these feeds can very well be determined by entering the arm through the fistula opening and retrieving the material (boli) before it settles into the mass of rumen ingesta. These boli are then dried and broken down for a physical analysis.

INTERESTING RESULTS OF MASTICATION OF FINE-CUT AND COARSE-CUT HAYS

The moduli of fineness of the masticated bolus of whole hay was less than that of the coarse-cut hay even though the animal actually did more chewing on the coarse-cut hay. Only a very small amount of mastication was done on the fine-cut or ground hay. It is significant also that as much chewing was done on finely prepared hay as that on the whole or coarse-cut hay, indicating that more mixing must be done in the mouth for moistening purposes on the finely prepared hay. The disintegration of the various hays by the mastication process is as follows:

	Whole	Coarse cut	Fine cut	Ground
Original hay		4.37	3.37	3.58
Masticated bolus	3.65	3.75	3.35	3.50
Difference		0.62	0.02	0.08

In most cases the younger animals showed more activity in mastication with the result that a greater disintegration of the feed was accomplished.

The rumination process is one in which considerable disintegration of the feed takes place, as the animal spends from 12 to 20 per cent of its time in this process. Analysis for rumination was made by the same method as that employed on mastication. Following is the disintegration of the feed by the rumination process:

DISINTEGRATION OF INGESTA BY THE RUMINATION PROCESS
(Measured by Moduli of Fineness)

Process	Whole hay	Coarse cut	Fine cut	Ground
Mastication	3.65	3.75	3.35	3.50
Rumination	2.95	2.90	2.40	2.80
Difference	0.70	0.85	0.95	0.70

In some cases the rumen ingesta had a higher modulus of fineness at the end of 16 hours after feeding than it had at 2 hours after feeding. This is undoubtedly due to the fact that the very fine material passes on to the third or fourth stomach, leaving the coarser material for further disintegration. Of significant importance was the fact that the whole hay ingesta was usually finer than that of the other preparations.

Crude fiber and protein determinations were made also, but the time allotted me will not permit a discussion on this most important phase of the problem.

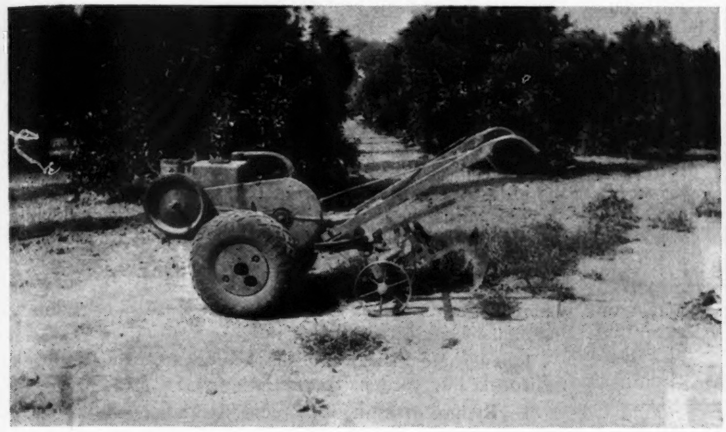



FIG. 1 (LEFT) A RUBBER-TIRE-EQUIPPED TRACTOR USED IN SOUTHERN CALIFORNIA TO CULTIVATE 13 ACRES OF ORANGES. FIG. 2 (RIGHT) THIS TRACTOR USED FOR CULTIVATING TOMATOES, PLOWING, HARROWING, AND PUMPING. OPERATES APPROXIMATELY 600 HOURS PER YEAR

The Garden Tractor in California

By K. R. Frost

PRESENT tendencies point toward a general increase in the use of small tractors in California. This is largely due to a greater number of small suburban farms, part-time farmers, lack of horses and of knowledge regarding their use, and the growing tendency toward a mechanically minded population. Improvements in design and quality of garden tractors have enabled them to compete with animals, hence many small operators are replacing horses with mechanical units.

In order to obtain additional facts regarding the operating performance of garden tractors, the Agricultural Engineering Division of the University of California authorized the author to conduct a limited farm survey. Ninety-one owners were interviewed personally to obtain reactions relating to the performance of their machines. The data included (1) type of work, (2) per cent of owners satisfied, (3) general performance, (4) length of operating life, (5) size of farm, (6) make and size of tractor, (7) costs, and (8) operator's recommendations.

The garden tractors were used in five different types of agricultural projects, namely, specialized row crops, general market vegetable crops, orchards or vineyards, commercial nurseries, and estates or parks. Each type of project had its specific tillage requirements, thus affecting the operations required of each tractor. A large percentage of the tractors were used for cultivation while only about one-half required plowing as one of the operations. Other work accomplished by these tractors consisted of hauling, pumping, mowing, trail blazing, furrowing, mixing fertilizer, and preparing hotbeds. Only 19 per cent of the tractors, however, were recorded as doing these miscellaneous operations. It is doubtful if other motive power could be used more advantageously under the conditions as they existed with these operators. Only one operator preferred the use of horses to that of the tractor, and his apparent reason for not using horses was the high maintenance cost.

Seventy owners, or 77 per cent of those contacted, were fully satisfied with the performance of their tractors, while many others were moderately so. The dissatisfied owners were quite evenly divided among the various enterprises indicating that dissatisfaction is not connected with a particular type of work.

Dissatisfaction as expressed by some owners was due to poor traction, insufficient power, unsuitability, and difficult handling. Mechanical breakage was not a major cause of dissatisfaction although a few operators had experienced considerable trouble. The more recent models are proving more satisfactory. Many owners of the older tractors complained of poor handling and traction. Improvement in performance is largely due to better balance, better steering controls, and the addition of a gear shift for reverse speed. Seventy-five per cent of the owners stated that their tractors controlled favorably for close cultivation and turning at the end of the field.

The period these tractors were used varied from 20 to 1000 hours annually while the average was 394. Many tractors had been used for 5 or 6 years without requiring repairs or showing serious wear. Results indicate that an operating life of 7 to 10 years can be expected.

The maximum acreage covered by any one tractor was 35 acres of specialized row crops. This was light cultivating work where no other operation was required of the tractor. In this case the tractor was required to operate 10 hours per day continuously for 3 months in order to properly control the weeds. The average size of farm was 7 acres, and the minimum size was 1 acre.

Twelve makes of tractors were included in the survey in sizes of 1 to 10 brake horsepower. The general-purpose garden tractors of 3 to 6 horsepower are the most popular, due to their versatility. Power cultivators are used almost exclusively in the specialized row crops, while the large garden tractors of 6 to 10 horsepower are used in open field and orchard cultivation.

Cost data were obtained and calculations made for the total expense of operating each make of tractor. In some cases complete cost data were unavailable; however, sufficient details were obtained to enable an estimation of the

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total expense. The first investment was the most important factor, being 62 per cent of the total, followed by fuel and oil. The average fuel consumption was ⅓ gallon per hour, oil 0.6 quart per day, and repairs amounted to an average for all tractors of $7.20 per annum including tool upkeep. The calculated average cost per rated brake horsepower per hour was 7.2 cents on an assumed life of 7 years.

It was possible on the basis of the above information and a purchase price of $100 per brake horsepower to obtain a relationship between first investment, number of operating hours per year, and the total cost per hour. The average cost per brake horsepower is shown in Fig. 4 to be approximately $100 for all garden tractors on the market. The effect of first investment and hours of operation upon the total expense of operating a garden tractor is expressed by the formula

$$\text{Dollar cost per hour} = \frac{0.46 \times \text{first investment}}{\text{Annual hours of operation} + 242}$$

Under normal operating conditions results from this formula give 16 to 45 cents per hour as the total expense, depending on the size of the tractor. The lines in Fig. 3 are plotted from this formula for an annual operating period of 150 to 800 hours. This formula is not applicable in cases where the tractor operates less than 125 hours per year.

A definite relation between hours of operation and the investment in a garden tractor is important because of the wide range of time garden tractors are used each year and the relatively high ratio of first investment to the annual operating period. Such factors as type of soil, service, work, or mechanical construction are not represented in this approximation although they influence the operating expense. To those who are not acquainted with this equipment, the formula should be considered as an indication of probable costs.

Recommendations offered by many of the operators included such improvements as better materials in the brackets, hitches, and braces, more clearance for row crop cultivation, greater adjustability of tread, lower fuel and oil consumption, more speed and power, and better traction. A few of the operators were unable to give constructive criticisms as their tractors had operated perfectly under their conditions.

Various contacts made during the survey indicated that the garden tractor industry is at present handicapped by the lack of reliable local representatives. The dealer must give demonstrations and be able to recommend the proper size and type of tractor for the prospective buyer. Satisfactory sales are obtained as a result of successful performance of the tractor and its ability to fill the operator's needs. The operator needs assistance and repairs which can be quickly supplied by a nearby concern. In so far as no one has perfected a method of selling garden tractors profitably, this phase of the industry is still in the formative stage.

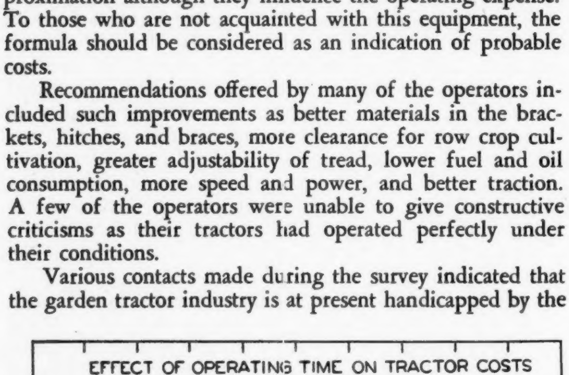
The garden tractor as it exists today is a very flexible machine, capable of almost any job in the lower power range. It might be defined as a low-investment power unit that operates at much less than animal power to be used where larger tractors cannot operate or circumstances do not warrant a large investment.

I have here listed some of the reasons why people in California buy garden tractors:

1. Reduce investment per acre
2. Lower than horse operating costs
3. Operate in close quarters
4. Enable accurate, careful cultivation
5. Make use of their spare time, or as a hobby
6. Be independent of outside hiring
7. Reduce hand labor to a minimum
8. Make it possible to do the work at the proper time.

GARDEN TRACTOR SURVEY RESULTS (1935)

	Number	Per cent of total
Total number of tractors	91	
Satisfied owners	70	77
Those having mechanical trouble	62	68
Those having sufficient traction	80	88
Those having sufficient power	69	76
Those used for plowing	51	57
Those used for cultivating	81	90
Those used for other work	17	19
Those that handled easily	68	75
Average number of hours used annually	394	
Average size of farm (acreage per tractor)	7	
Average age of tractors, years	3.9	
Number of horses displaced	1 to 3	
Average repair cost per tractor per year, including tool upkeep	$7.20	
Average fuel consumption per hour, gal	⅓	
Average oil consumption per day, qt	0.6	
Average cost per brake horsepower per hour, cents	7.2	



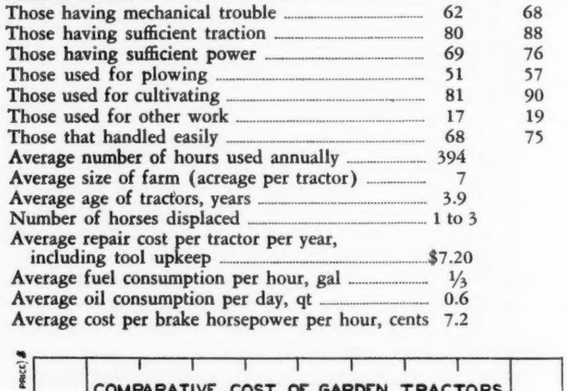


FIG. 3 (LEFT) THE RELATIVE COST OF OWNING VARIOUS SIZES OF TRACTORS AS AFFECTED BY NUMBER OF HOURS OF OPERATION PER YEAR. THIS IS BASED ON A SEVEN-YEAR LIFE AND AN AVERAGE OPERATING PERIOD OF 394 HOURS PER YEAR. FIG. 4 (RIGHT) COST PER BRAKE HORSEPOWER (MANUFACTURER'S RATING) FOR VARIOUS SIZES OF GARDEN TRACTORS ON THE WEST COAST. EASTERN PRICES ARE PROBABLY 5 TO 10 PER CENT LOWER

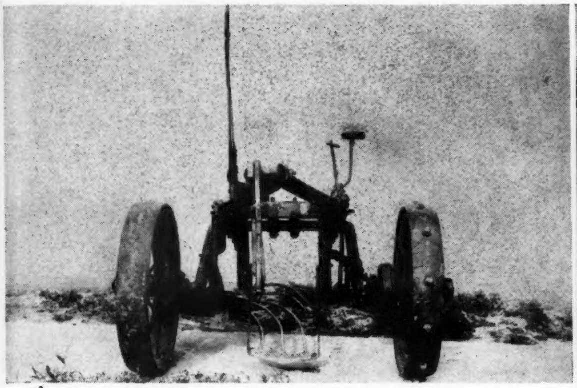


FIG. 1 (LEFT) FRONT VIEW OF SINGLE-UNIT CONTOUR FURROWING MACHINE. FIG. 2 (RIGHT) A PROPERLY PLACED SOD STRIP THREE TO FOUR INCHES BELOW THE FURROW WALL

A Pasture Contour Furrowing Machine

By C. A. Logan

THE CONTOUR furrowing of pastures is a new practice in Kansas, and one that is creating much interest, especially in the short-grass regions of limited rainfall. The greater part of this interest can be attributed to the results obtained with a new type of machine developed on the Limestone Creek demonstrational area of the Soil Conservation Service near Mankato, Kansas.

During the early stages of the soil conservation program on this area, it was quite generally recognized that the pastures needed something besides a properly regulated grazing program. The buffalo sod pastures were so closely grazed that they were gullying badly and the grass was dying for lack of moisture.

Plowing contour furrows in the pastures to hold the runoff water, although tried in other states had never been practiced in Kansas; yet, it seemed the logical solution to the problem. Consequently, in May of 1934 a pasture was surveyed and level furrows were plowed with a road plow at horizontal intervals of 16 to 20 feet with the sod thrown to the lower side of the furrow. This method was not satisfactory for several reasons as follows: (1) The strip plowed out was so broken that it did not form a water-tight levee; (2) the grass turned over could not continue growing; (3) the furrows were unsightly and promoted weed growth; (4) the broken pieces of sod would make it difficult to mow the weeds, and (5) it would require longer for the disturbed area to grass over than were the sod strip left in an upright position.

To eliminate these objectionable features another pasture was contour-furrowed and the sod was first plowed out to the upper side of the furrow. The plow was then run in the same furrow throwing loose soil on the lower side, and hand labor was used to place the sod on the loose soil with the grass side up forming a water-tight levee.

The finished product was quite satisfactory and had eliminated all of the objectionable features of the first method, but a new element had entered into the picture. The hand labor necessary to place the sod proved expensive, and its cost was more than most pastures are worth. It was then decided that this last objectionable feature could be eliminated by building a plow with a set of curved rods which would cut the sod strip, raise it, and place it right side up on the lower side of the furrow all in one operation, and eliminate all hand labor. Consequently, with this idea in mind H. L. Gamble and A. J. McCleery, two engineers on the project, were given the task of building and developing such a machine, and to them a great deal of credit is due for the successful performance of their task.

Many difficulties were encountered, and much use of the trial-and-error method was made before a satisfactory unit was constructed. It was found that the proper curvature of the delivery rods varied somewhat with the moisture content of the soil and the denseness of the sod, and that the rods worked best when approximately five feet in length.

To obtain a good bond between the sod strip and the ground upon which it was placed, a set of small ripper teeth was used to tear up the sod and loosen the soil, and a 230-pound packer was used to press down the sod strip. In moist soil this ripper became clogged with roots and trash, and it was replaced by a piece of grader blade fastened to an adjustable beam as shown to the right of the cutting blade in Fig. 1. This blade removes the grass from the area where the strip is placed and allows the transplanted sod to be placed directly on the soil. To keep trash from clogging under the cutting edge, the toe of this blade should be adjusted about ¾ inch deep when the heel is just entering the ground. When this stripper blade is used, a roller to pack the sod strip is not necessary as the roots can reenter the soil immediately, and the first rain will make a good seal between the two surfaces.

Fig. 2 shows a properly placed sod strip. When the strip is placed three to four inches below the furrow wall, it lessens the possibility of breaking down the side wall, and the narrow strip of growing grass aids in making a water-tight seal, as well as decreasing the length of time required to grass over the bottom of the furrow. The effectiveness of this seal is shown in Fig. 3.

In using the machine shown in Fig. 1 it was possible to

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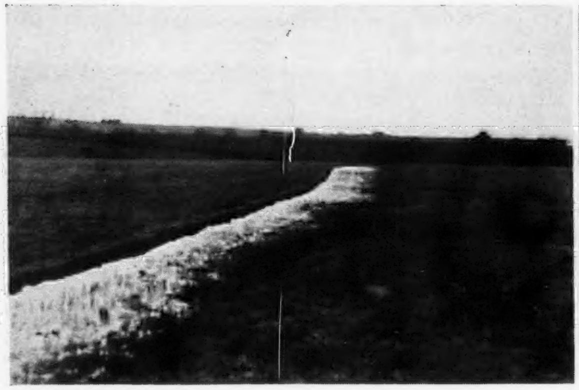


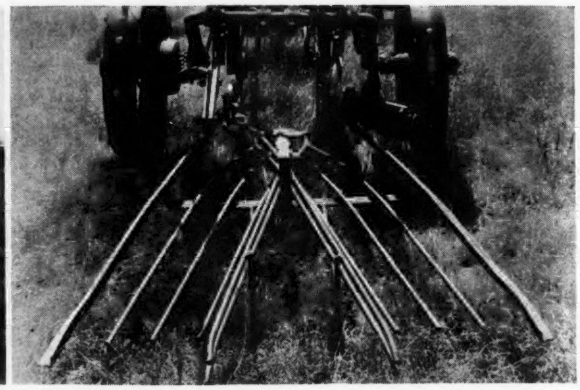


FIG. 3 (LEFT) ILLUSTRATING HOW A SOD STRIP WITH A GOOD SEAL IMPOUNDS WATER. FIG. 4 (RIGHT) THIS IS A REAR VIEW OF THE TWO-WAY CONTOUR FURROWING MACHINE. IT IS REVERSED BY PULLING A PIN AND REVERSING THE CENTER SEGMENT OF RODS

work in only one direction in order to place the sod strip below the furrow. To eliminate the lost time in return trips, a two-way machine was developed in August which would deliver the strip to either the right or left side. Fig. 4 shows a rear view of this machine.

Considerable trouble was encountered in moist sod with this two-way unit from the clogging of roots and trash between the rods. This was eliminated by replacing the movable section of guide rods with a flat piece of polished metal.

One disadvantage in the operation of the two-way machine is the fact that the sod must be removed from the rods before the movable guide can be reversed. Where the furrows do not exceed 600 to 800 feet in length, it is usually more economical to work in one direction only, rather than to reverse and plow in both directions. The minimum length of furrow at which it is more economical to reverse depends upon the motive power, nature of the sod, type of layout, and whether one or two men are operating the machine. It is possible that in large-scale operation it would be much more economical to have independent right and left units mounted on one frame.

At various times during the work with both machines some trouble was experienced with a collection of tough weeds and roots on the vertical cutting edges of the U-shaped blade. This condition was more noticeable in loose moist soil and a considerable improvement was made by sloping the vertical cutting edges forward at approximately 35 degrees.

There are still many improvements which will probably be made as a more intensive use under varying conditions will require, but in general both the one-way and two-way units have proved quite satisfactory in buffalo-sod pastures with a reasonably good sod.

Approximately 50 miles of pasture contour furrows have been made on the Limestone Creek demonstrational area, and the cooperators are enthusiastic over the results. In fact, after this machine had been used on a few pastures, it became quite difficult to obtain sod for outlet channels as the cooperators all desired that the sod be left on the lower side of the furrows. Data from experimental plots on the Limestone Creek area shows the contour furrows increased the forage growth about 29 per cent in 1935.

Fig. 5 shows a pasture soon after contouring, and Fig. 6 shows the same pasture late in August. The extra growth of grass and green strips of grass along the furrows are quite noticeable, and because of the results obtained on this pasture during a hot dry summer, the farmer said that he felt that pasture contouring was the best part of the entire program for him.

It would probably be much more satisfactory if a machine of this type could be produced commercially, yet a good mechanic and blacksmith can build a machine similar to the one used on the Kansas area at a relatively low cost. The frame is made out of an old two-bottom plow chassis with power lift and depth-regulating lever. The main axle was cut and welded in such a manner that the two main wheels were placed in an even plane and the plow beams

FIG. 5 (LEFT) A BUFFALO SOD PASTURE CONTOUR-FURROWED EARLY IN THE SPRING. FIG. 6 (RIGHT) THE SAME PASTURE AS FIG. 5. THIS PICTURE WAS TAKEN LATE IN AUGUST. NOTE EXTRA GROWTH AND GREEN GRASS ALONG THE FURROWS

were cut off and the rear one moved forward so that they carried the U-shaped knife as shown in Fig. 1. This knife was made from an old steel road-drag blade, and its details with those of the rods are shown in Fig. 7.

SUMMARY

1 Contour furrowing of overgrazed pastures eliminates the need for gully-control structures and increases the growth of grass.

2 Data from experimental plots on the Limestone Creek area show that the contour furrows increased the forage growth about 29 per cent in 1935.

3 Indications are that the best horizontal spacing between furrows is from 16 to 20 feet in the Limestone Creek area.

4 Soil-moisture conditions have some influence on the type of work done. If the sod is too dry, it breaks and if too wet the machine clogs.

5 The machine will not work where the soil is too loose or the grass stand too thin.

6 Much more satisfactory results are obtained by using a small blade to scrape the grass from the area where the sod strip is to be placed.

7 The sod strip should be placed three to four inches below the lower edge of the furrow wall.

8 It is not economical to reverse the two-way machine when the furrows are less than 600 feet long.

9 The contour furrowing machine has the following advantages over a plow or small blade for contouring pastures:

(a) It leaves a much neater appearing job.

(b) The grass on the sod strip is not destroyed and may go right on growing if weather conditions are favorable.

(c) The strip is unbroken and forms a continuous levee.

(d) It lessens the amount of weed growth along the disturbed area.

(e) It is easier to mow along the strips.

(f) It requires less time for the furrows to become resodded.

(g) It is an economical method of contour-furrowing pasture land.

Cutting Edges of Tillage Implements

(Continued from page 97)

hard ply may be worn the greatest amount at a number of different points along the entire edge. Fig. 7 shows in detail the characteristic manner of wearing of soft-center steel edges in service. It would appear difficult for even the most skillful of blacksmiths to draw out the top hard ply to a satisfactory edge throughout the entire length.

Conclusions with reference to the results, except those with reference to results stated above, are purposely omitted. The work may seem sporadic to some degree, but it appears desirable to some extent to explore the method of approach. Such work, however, has important aspects from the standpoint of the establishment of working hypotheses. The results are gratifying from this point of view, for already certain relationships are indicated. It is regarded that these indications are even more fundamental than the principles now used for some of the existing practices.

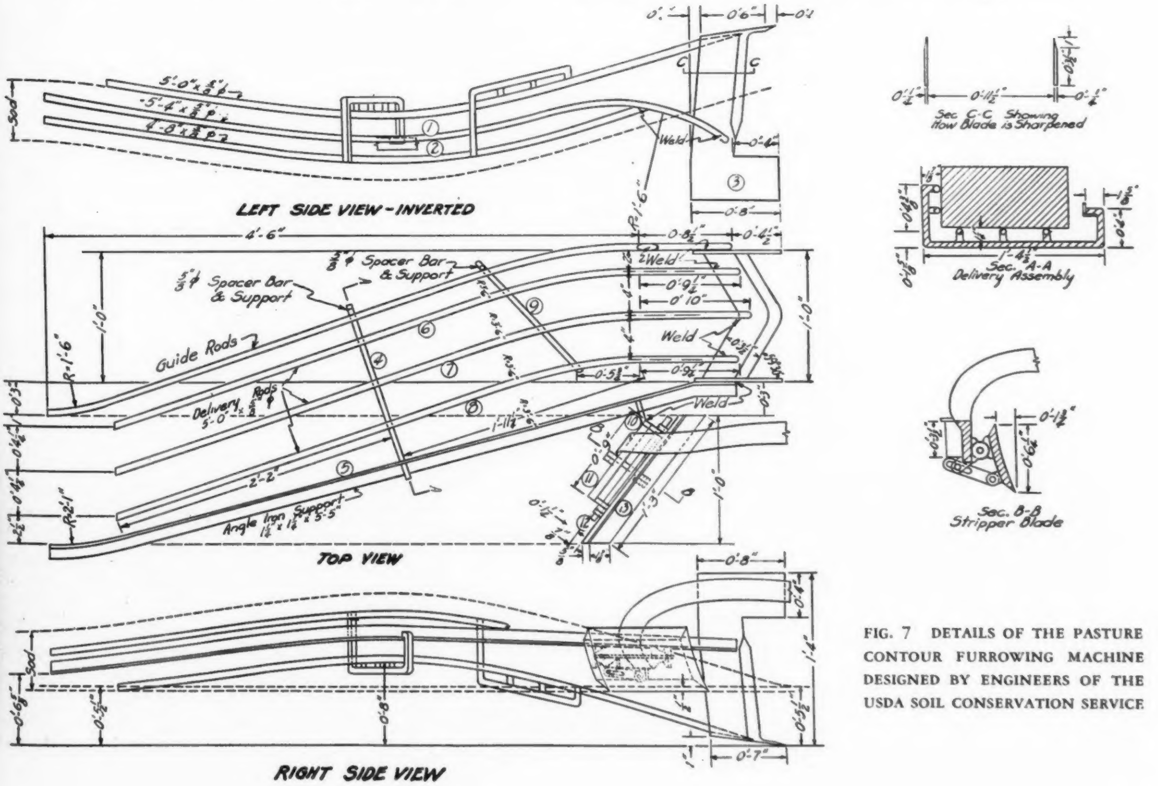


FIG. 7 DETAILS OF THE PASTURE CONTOUR FURROWING MACHINE DESIGNED BY ENGINEERS OF THE USDA SOIL CONSERVATION SERVICE

An Engineer's View of Land-Use Planning

By H. B. Walker

LAND is a basic resource, and, as such, it should be inventoried through adequate soil survey methods for a fundamental land-use foundation. However, land in itself does not constitute a complete criterion since its elements are unavailable for productivity unless unlocked by the favorable action of heat and moisture. Thus climate, including rainfall, length of growing season, and facilities for water storage, both surface and subsurface, are factors not to be overlooked in making appraisals.

A soil profile is not a permanent thing, since it is subject to many modifications by natural and artificial forces such as erosion, accretions, leveling, and mining. But these basic factors are to a great extent immobile factors. For example, a fertile valley is a fixed resource; the water-bearing gravels below are fixed; nature has provided, or not provided, water through rainfall, or mountain storage through snows. These natural resources constitute basic resources to be systemmatically inventoried, and it is upon these that sound land-use programs are built. Such information has present and potential value.

Studies based upon existing use are secondary but none the less sound when properly coordinated with the basic resources. These uses are a result of the basic resources, and where continued utilization has developed long-time and sustained profitable use, such factors constitute an effective and rapid means of reaching reasonably sound inventories. It does, however, constitute a static type of inventory.

For the most part, inventories of natural resources normally carried out through soil surveys, topographic surveys, meteorological studies, underground and surface water investigations, etc., while indispensable, are slow, tedious, and expensive. These methods, therefore, must be coordinated, but to lean too heavily on existing uses and to neglect a program for the systematic appraisal of the basic natural resources is not the best type of land-use planning.

Conservation of resources is a part of sensible land utilization. This too must be coordinated with good land use. It is influenced by economics as well as location of resources. To spend huge sums to conserve resources of small or doubtful value when other areas more valuable in basic resources are neglected, and when the funds spent otherwise would accomplish more real conservation, is not logical conservation, because it does not take into account the best basic resources.

Such errors, if made, are due largely to a lack of data relating to primary resources such as are acquired through soil and water surveys. As engineers we should insist on adequate support and comprehensive programs for the execution of such basic inventories.

Then we are confronted with certain factors of mobility. Our population although variable in density remains essentially mobile. It is more mobile today than ever before due to the many facilities now available for mobility. This mobility is a factor in land use. Its influence is not readily predictable due to the variable economic factors involved. Here again we are dealing with a factor which comes as a result of basic resources distribution. The fact that people are concentrated in certain areas indicates the essential tendency for folks to follow resources of various types. The same forces which cause them to concentrate are effective for dispersion, and these forces of mobility are logical only when the contributing basic resources are known and programs are outlined to bring about effective utilization.

It is folly to expect rapid changes in land use no matter how apparent these may appear. Traditions in industry, agriculture, and society in general, mitigate against this. Land-use programs must be evolutionary rather than revolutionary. They must be based upon facts rather than fancies or idealism. Directional programs rather than dictatorial ones no doubt will be most effective. There is, however, no excuse for neglect in accumulating data relating to basic resources. This is clearly a public responsibility.

In what way may the American Society of Agricultural Engineers contribute to a logical land-use program? Our most important duty is to support wholeheartedly the agencies responsible for the collection and interpretation of basic resources data, such as the soil survey, water resources investigations, topographical surveys, and others. This is a duty of our Society membership as a whole.

Concerning other contributions, our position is not so well defined. We have in our Society, soil conservation, including terracing, drainage, land clearing, and irrigation; power and machinery; structures and utilities, and rural electrification. There can be no question regarding interest, but the type of contribution we are able to make is a little less clear.

Soil conservation is basic, if we consider it from the standpoint of keeping in a high state of efficiency the natural and potential productive capacity of our agricultural lands. Our greatest erosion losses occur on lands used for productive purposes, where the combination of surface terrain, precipitation, and wind action work together to produce changes in the soil profile. The maintenance of such soil surface involves engineering methods and works of construction which will be in harmony with effective land use.

With drainage and irrigation the problems are much the same, except as to the function of works involved. Both of these are of fundamental importance when associated with the potential development of our natural soil and water resources. Here again coordination is needed if land-use programs are to be made effective.

In the field of power and machinery we are concerned with a mobile influence. Future developments will depend more or less upon economic influences which are constantly changing. Present practices are not good criteria of future progress. In this we deal with dynamic forces which greatly influence the usefulness of natural resources. If agricultural populations become more dense, unit holdings will become smaller and production intensified. This may call for smaller units for individual operation or management, or the formation of agricultural guilds permitting even greater specialization with larger operating equipment. New methods of soil conservation, such as terracing, call for new machine applications and performance, if not new machines. The engineer and *(Continued on page 119)*

Portion of a letter from the chairman of the ASAE Committee on Land Use, American Society of Agricultural Engineers, to the members of the Committee.

Author: Professor of agricultural engineering, University of California. Mem. ASAE.

Characteristics of Spray Nozzles for Vegetable and Weed Spraying

By O. C. French and A. S. Crafts

ALTHOUGH considerable work has been done in perfecting equipment for spraying trees and vines, there is little published information on nozzles for treating low-growing crops and for applying herbicides and soil sterilants. With the increasing need for insecticides and herbicides in the growing of field crops, spraying operations concerned primarily with area coverage are claiming more attention. This type of spraying differs in several essentials from the usual practice used in pest control in orchards and vineyards. This paper discusses some of these differences and gives data useful in the designing of equipment for field work.

Economical treatment of weeds and vegetable crops requires primarily a uniform coverage of a given area of vegetation with proper penetration of the spray solution. Since the distance from the spray nozzles to the vegetation is relatively short, the high pressures used in spraying trees are not required. In fact, excessive pressures usually defeat the purpose of the application by blowing the spray solution from the leaves. Furthermore, with such materials as sulfuric acid, diesel oil, and the arsenical herbicides and insecticides, drifting of the highly atomized spray solution is undesirable. Usually, in consequence, equipment designed for weed and vegetable spraying requires a low-pressure, high-volume pump and a multiple nozzle boom arranged to cover the vegetation in the most efficient manner.

One essential feature of efficient equipment of the type mentioned is a nozzle giving a flat, fan-shaped spray. The spray from a plain circular orifice tends to be heavy in the center and light on the edges. The hollow-cone type of delivery is heavy on the edges and deficient in the center. The ordinary bordeaux type of nozzle, though giving a flat spray, lacks uniformity and is difficult to standardize. A nozzle that appeared to have the required characteristics is the "Hummer," made by the Friend Manufacturing Company and adapted to weed spraying by the Chipman Chemical Company. Studies on several nozzles furnished by the latter company, however, showed that even these were unreliable for use in multiple-nozzle work. Although manufactured under five different designations, there proved to be only three sizes. Nos. 1 and 2 had practically the same sized orifice, and Nos. 4 and K3 were also alike. Furthermore, among disks of the same number, the angle of spread of the fan differed widely. A notable case was found among a group of K3 disks which varied in the angle of spread from 22.5 to 45.0 degrees. Obviously the use of such nozzles in a multiple nozzle boom would not give a uniform distribution of the spray solution.

Studies of the design of disks for flat, fan-spray delivery have shown that, with some slight changes, the disks provided in the "Hummer" nozzle are satisfactory. Standardization of the improved disks proved relatively simple. Since these disks used in the standard "Hummer" nozzle provide the essential unit for boom construction, the characteristics have been studied. The data are presented here in the hope that they will prove useful.

Since the initial studies involved design of equipment for use with dilute sulfuric acid, sheet nickel was used in making the disks. They were punched from 22-gauge material by means of the disk cut-out punch shown in Fig. 1. The disks were then placed in the forming die, and the raised ridge shown in Fig. 2 was formed. This is done by striking the plunger a sharp blow with a 1¾-pound hammer, forcing the disk into the babbit mold by means of the shaped plunger (A) illustrated in Fig. 1.

After forming, the disk is drilled by holding it firmly between the thumb and forefinger of each hand with the concave side up and forcing it upward against a revolving drill of the required size. When the hole is made, the disk is removed and turned over. Then, grasped firmly, it is again raised on the drill and carefully rocked, widening the hole at right angles to the length of the raised ridge. This widening of the orifice determines the included angle of spread of the spray fan and must be carefully done if a standard angle is desired. The disks to be described were standardized at approximately 60 degrees spread at 75 pounds pressure. With a little experience, this shaping of the orifice can be so accurate that disks giving a uniform spread may be made. An angle of 60 degrees was selected as the most convenient to use in boom design.

When in use, these disks are placed in the nozzles with the *concave* side *out*. This forms the fan in a plane parallel to the groove and gives a more uniform distribution of the spray solution. A screw driver is useful in orienting the disks along a boom. When rubber washers are used behind the disks, little pressure is required to hold them in place, and the caps that hold them may be screwed in place with the fingers. If a wrench or pliers are used, the rubber

Authors: Respectively, instructor in agricultural engineering and junior agricultural engineer in the agricultural experiment station (Jun. ASAE), and assistant botanist in the experiment station, University of California.

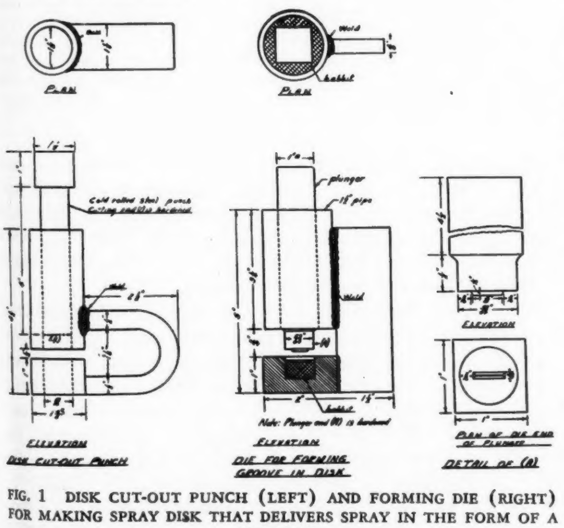


FIG. 1 DISK CUT-OUT PUNCH (LEFT) AND FORMING DIE (RIGHT) FOR MAKING SPRAY DISK THAT DELIVERS SPRAY IN THE FORM OF A FLAT FAN

washer is usually forced into the cup-shaped base, and the nozzle leaks.

For the calibration of these nozzles thirty disks were made, and five were drilled with each of the following drills: Nos. 57, 56, 55, 53, 51, and 46. Using a tested pressure gauge, the disks were run for three minutes each at 100 pounds pressure, and the discharge was collected and weighed. The five values were then totaled, and the disk that discharged nearest to the average value was run at 25, 50, 75, and 150 pounds pressure. All five disks of size 56 were tested at the five pressures. From these data the calibration curves shown in Fig. 3 were drawn. These curves enable one to find the discharge rate of disks of known orifice size at any pressure up to 150 pounds per square inch. Experience has shown that, with the smaller orifice sizes, pressures above 100 pounds with this type of nozzle produce excessive atomization and result in drifting of the spray solution. A pressure of 75 pounds gives the best results. The curves of Fig. 4 have been derived from the calibration data; they show the relation between orifice size and discharge at the different pressures used. Within the limits of the orifice sizes and pressures used this relationship follows a straight line for each pressure and may be expressed by the formula $Y = Kx\text{-}a$. The K and a values are written in on each of the curves. One might extrapolate somewhat beyond the limits of pressure and orifice size given here with the relative safety, but for diameters above 0.1 inch it would be well to check to make sure this relationship still held.

STUDIES WERE MADE TO DETERMINE THE DRIVING FORCE OF THE SPRAY

Because the penetrating power of the spray solution into dense foliage depends largely upon the force or inertia of the particles, which in turn is related directly to the pressure at the nozzle, studies were made on the driving force of the spray. The testing equipment consisted of a sheet of galvanized iron 6 inches wide and 2 feet long, pivoted at its upper end and counterbalanced. A small container for weights was hung on the lower end, and the sheet, ready for use, was balanced to hang at an angle of 45 degrees, sloping away from the nozzle.

When the spray, directed horizontally, was played against the sheet, it would swing up toward a horizontal position. Weights would then be added to the container hanging from the lower end until the sheet again came to 45 degrees. The spray stream was centered about a line drawn across the sheet 1 foot from the pivoted end. At 45 degrees the weight hanging vertically from the end, 2 feet from the pivot, was valued at one-half the horizontal force centered at the 1-foot mark.

With the nozzle 2 feet from the testing apparatus, five disks each of sizes 56, 53, and 46 were studied; the data are illustrated in Fig. 5. A number of trial runs at various pressures indicated that the relation between driving force and pressure at the nozzle was a straight-line one. Therefore, since for practical use these curves should give representative values for the orifice sizes tested, and since the error of the determination is less at higher pressures, the test runs reported were conducted at 150 pounds pressure, and each value on this line represents the average for five disks, each operated in two positions. As these curves show, the driving force within the distance measured was directly proportional to the pressure at the nozzle. The force of the spray from the disks of larger orifice size was larger, and at a given pressure varied roughly with the volume delivered or with the square of the diameter.

In boom design the height from the ground or foliage level is an important factor as related to penetration, rate of delivery, and drift. To study the effects of different heights these same sets of nozzles were tested at distances of 1 foot and 3 feet. These data, with those at 2 feet already presented, are given in Fig. 6. All values were determined at 150 pounds pressure.

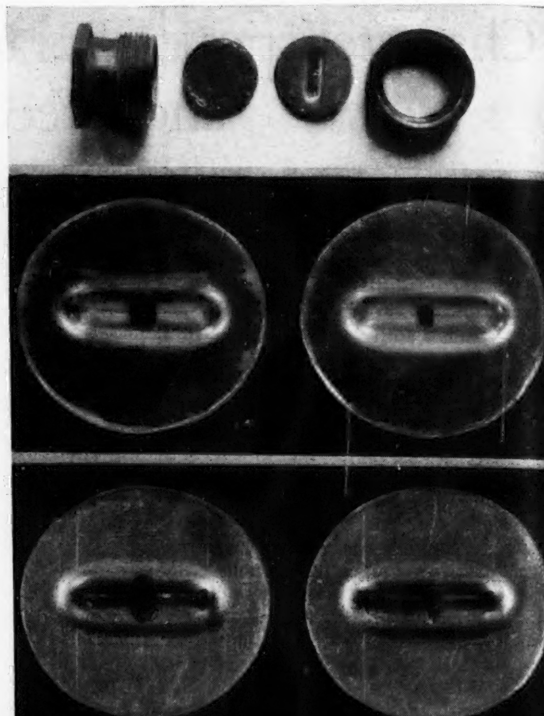
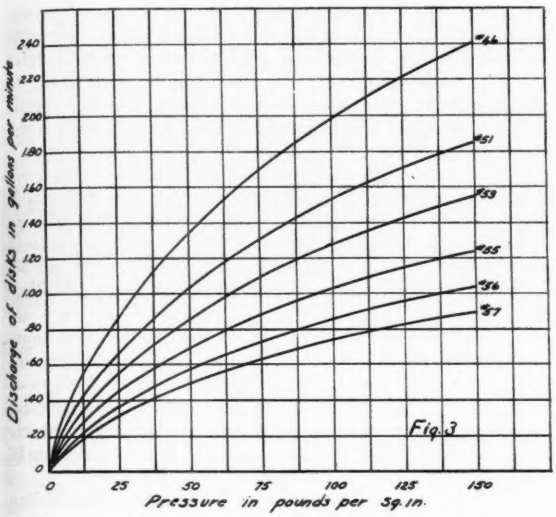


FIG. 2 NOZZLE ASSEMBLY AND DETAILS OF DISKS. NOZZLE ASSEMBLY (TOP) FROM LEFT TO RIGHT: NOZZLE BASE, SCREEN, DISK, CAP. A RUBBER OR FIBER WASHER IS USED BETWEEN THE BASE AND DISK. THE SCREEN IS NOT REQUIRED IF AN ADEQUATE FILTER IS INCLUDED IN THE EQUIPMENT. NOS. 46 AND 56 DISKS ARE SHOWN WITH CONVEX SIDE OF RAISED RIDGE UP (ABOVE) AND CONCAVE SIDE UP (CENTER). THE LOWER PHOTOGRAPHS SHOW THE RAISED RIDGES TAKEN PARALLEL TO THE RIDGE (UPPER) AND AT RIGHT ANGLES TO RIDGE (LOWER)

In interpreting these curves, it should be remembered that the testing instrument was 6 inches wide. Consequently, with increase in the distance from the nozzle a decreased proportion of the spray fan came in contact with the instrument. Neglecting loss in force due to wind resistance and atomization, the force at any distance multiplied by the distance should be a constant; and for any one orifice size the relationship between force and distance should be $Y = Kx$, where Y = force, x = distance, and K is a constant characteristic of the particular disk. This equation, if



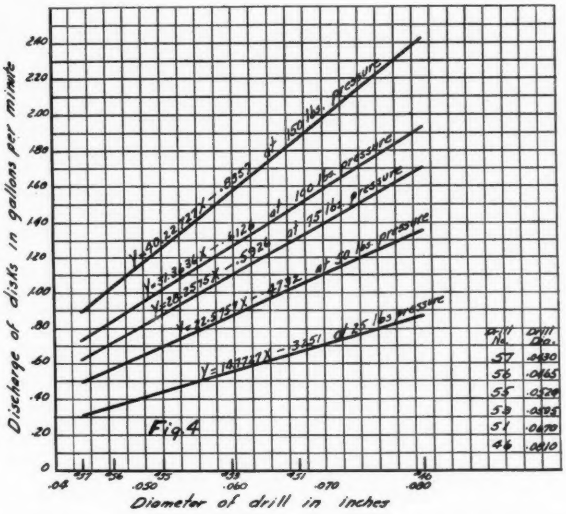
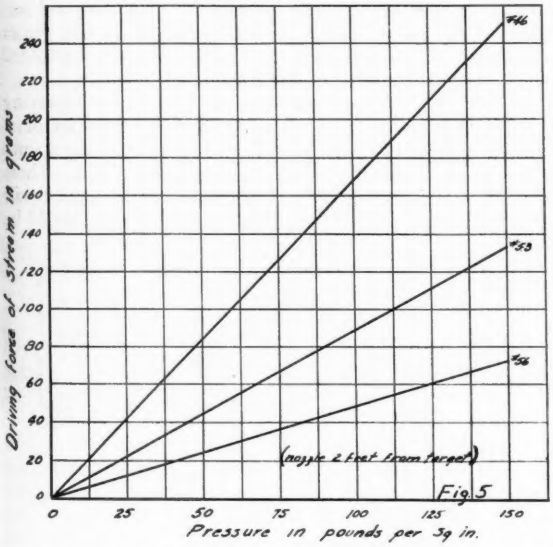


FIG. 3 (LEFT) CALIBRATION CURVES FOR DISKS DRILLED WITH NOS. 57, 56, 55, 53, 51, AND 46 DRILLS. FIG. 4 (RIGHT) CURVES SHOWING RELATION BETWEEN ORIFICE SIZE OF DISK AND DISCHARGE AT DIFFERENT PRESSURES



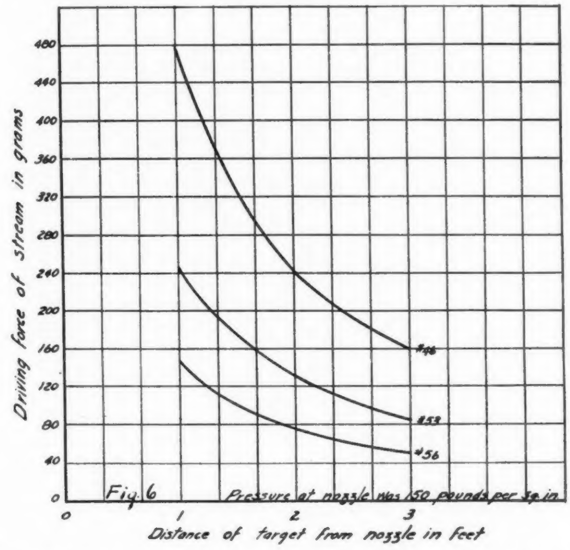


FIG. 5 (LEFT) THE RELATION BETWEEN PRESSURE AT THE NOZZLE AND DRIVING FORCE OF THE DISCHARGED SPRAY SOLUTION AT A DISTANCE OF 2 FEET. FIG. 6 (RIGHT) THE RELATION BETWEEN DRIVING FORCE OF THE SPRAY AND DISTANCE BETWEEN NOZZLE AND TARGET FOR DISKS NOS. 46, 53, AND 56

plotted, gives a parabola with $Y = K$ on the 1 foot ordinate. Since the experimental values given by the tests lay so close to the curves given by this equation, it may be assumed, for all practical purposes, that no driving force is lost by the spray from these nozzles within the first 3 feet and that the force at any point is inversely proportional to the distance from the nozzle. This generalization would not hold for nozzles smaller than number 56 but could probably be extended to 4 feet or more for the number 46 or larger orifice sizes.

Another matter that needs consideration in boom design is the change in angle of the spray fan with increased pressures. At low pressures surface tension tends to draw the edges of the fans together, giving a narrow angle. With increasing pressures the angle widens until it approaches a maximum at something above 150 pounds. The disks used in the foregoing studies were all tested for change of angle with pressure; the results, averaged for each set of five replicate disks, are given in Fig. 7. It was apparent from the results that a family of parallel curves was formed; and since their relative positions bore no relation to the orifice sizes, but were related to the angles of the fans, it seemed that a curve giving the average of all the values would be most representative of the behavior of the disks. Such a curve has been drawn in.

In view of the various relationships that have been presented, correct design of a multiple-nozzle boom is obviously not a simple matter. Fortunately, certain values, for economic or mechanical reasons, are limited or fixed.

A pressure of 75 pounds per square inch at the nozzles is the most satisfactory for most field work where these nozzles are used. Higher pressures, especially with the

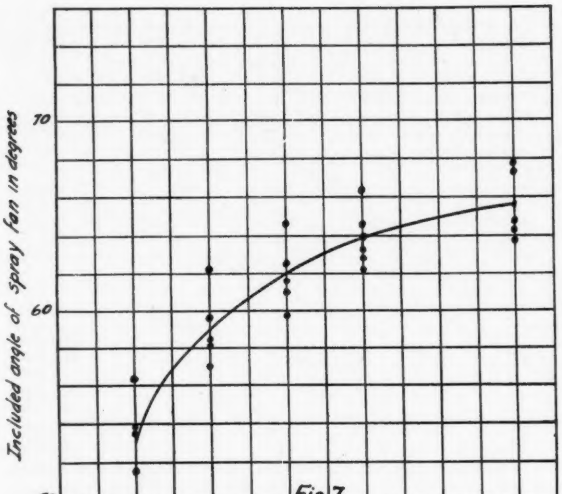


FIG. 7 CURVE SHOWING THE CHANGE IN ANGLE OF SPREAD OF THE SPRAY FAN WITH CHANGE OF PRESSURE AT THE NOZZLE

smaller orifice sizes, produce a drifting mist that is objectionable where oils, acids, or poisons are being applied. Where this mist is not a factor, pressures up to several hundred pounds may be used, giving extreme atomization. Pressures below 50 pounds do not give a satisfactory coverage.

Volumes may vary widely, according to the purpose of the treatment. An acre of young growing weeds or field crops can be adequately covered with about 100 gallons of spray solution and where water is simply being used as a carrier this quantity is usually sufficient. Heavy weed growth may take up to 300 gallons, and where it is necessary to supply excess moisture, as in the acid arsenical treatment, a total volume of 500 gallons or more may be desirable. With such a wide range in volumes, a comparable range in orifice sizes is needed. As shown by Fig. 3, by using number 57 disks at 50 pounds pressure a volume of ½ gallon per minute may be delivered. By using a number 46 disk at 150 pounds, 2½ gallons per minute are delivered. Even larger delivery may be had by using disks of larger orifice size. It is possible, therefore, simply by changing disks to alter the volume delivery of a given boom equipment through a range of five times or more.

The height of the boom and the spacing of the nozzles must be related where a complete ground cover is desired, and this relationship affects volume delivery for any given orifice size. For mechanical reasons adjustments should come between heights of 1 foot and 3 feet from the ground level. Between these limits, height of boom is largely a matter of convenience. Driving force as affecting coverage is, from Fig. 6, inversely related to distance but directly related to volume delivered. Therefore, with a given volume of spray solution per unit area covered, height does not materially affect penetration and coverage. Furthermore, the problem of drifting mist is greater with the disks of small orifice size, so that again with volume constant there is little difference within this range. One possible advantage of a high boom with wide nozzle spacing is that, where the water contains foreign matter, the large orifices will handle it with less screening. Under certain conditions this might effect a considerable saving of time.

The rate of travel of the spray rig is another factor in volume delivery. This rate depends largely upon the condition of the ground and the type of outfit. The equipment illustrated in Fig. 9 has been used at speeds up to 3 miles per hour with satisfactory results. It is often possible to operate a boom attached to the rear of a truck at this speed; and so long as coverage is satisfactory, high speeds make for economy in the treatment.

The arrangement of the nozzles on the boom is a matter of some importance. For area coverage there are two common types. The first is simply a single row of nozzles so spaced that the fans converge at the level of the vegetation being sprayed. Although this may be satisfactory, an arrangement giving much more uniform distribution is illustrated in Fig. 8. In this type two complete coverages are given from different angles; and by the staggered arrangement of the nozzles, whereby the centers of the fans directed back of the boom line with the converging edges of those pointed ahead, a very thorough coverage is effected. Tests have proved this to be the most satisfactory nozzle arrangement for weed spraying, and it might well be modified to apply to insecticide work on vegetables.

For convenience it is well to make provision for folding a long boom for travel and passage through gates. One arrangement is illustrated in Fig. 8. The two 1½-inch street ells are used to provide a hinge, and the threads are lubricated with heavy grease or asphalt. The two end sections of the boom may also be connected to the center section by means of pressure hose, and they may be folded back behind the center section for travel.

Equipment for general weed and vegetable spraying should consist of a powered pump having a capacity of at least 20 gallons per minute and capable of attaining a sufficient pressure to operate an injector-type refiller. There should be a large-capacity screen or filter to remove all particles above 0.03 inch in diameter. The boom should be

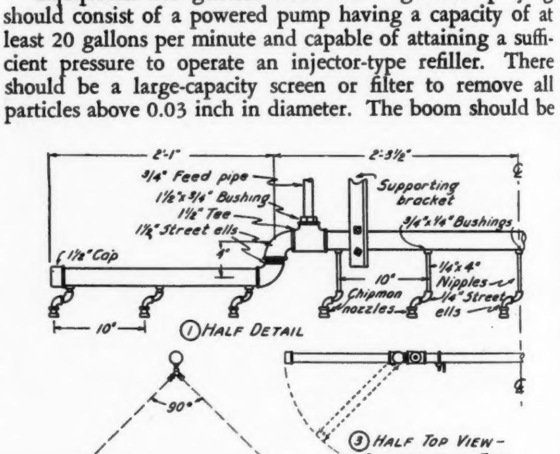


FIG. 8 BOOM DESIGNED FOR WEED SPRAYING. THE ESSENTIAL FEATURES OF THIS DESIGN ARE THE USE OF FLAT-FAN SPRAY NOZZLES, THE ALTERNATE ANGLING TO GIVE TWO COMPLETE COVERAGES, AND THE HINGING ARRANGEMENT FOR CONVENIENCE IN MOVING THROUGH NARROW GATES

FIG. 9 FIELD SPRAYER FOR APPLYING SULFURIC ACID: 20-GPM POWER TAKE-OFF PUMP, 400-GALLON TANK, 19-FOOT FOLDING BOOM

wide enough to utilize the capacity of the pump and to avoid excessive travel in the spray operation. For general weed spraying, covering possible variations in height of foliage, it should be adjustable between the heights of 1 and 3 feet.

If strong acid or alkaline sprays are to be applied, an ejector such as the Penberthy No. 62 should be included between the pump and boom, with provision for carrying the container of the corrosive material. Such an equipment was described by O. C. French and W. E. Ball in this journal (vol. 15, no. 12, December 1934), and also in University of California Bulletin No. 596, entitled "Sulfuric Acid for Control of Weeds, 1935." All pipe and fittings from the ejector to the boom should be acid-resistant material, such as Everdur brass. Smaller equipment may be built to scale to suit various requirements. It is always well to provide ample pump capacity and to allow for height adjustment in designing boom equipment. For hand-gun work, the nozzles described may be used singly or in combinations.

Lower Cost Farm Wiring

(Continued from page 100)

metallic cable, rather than 15 per cent, the present quotation.

As to the cost of 100-ampere vs. 60-ampere service entrance switches, we find that the former now costs the contractor $9.00, and the latter $4.13. This is a simple fused safety switch, all meter-testing facilities being furnished by the power company. While this difference in price will doubtless be narrowed as the 100-ampere switches are used in greater quantity, the other items going into a 100-ampere service bear a similar ratio to those of a 60-ampere service; that is, No. 2 entrance cable costs the contractor about 19.5 cents per foot, No. 6 cable costs 11.9 cents per foot, in quantities in which they would usually be bought. Likewise the capacity of the service is increased in approximately the same amount. The use of pole metering often eliminates the necessity of using any entrance switches larger than 60-ampere, since switches of this rating can be used on both house and barn, except where motors larger than 5 horsepower are to be used.

I, for one, can not assume to speak on field practices throughout the country. In my paper appearing in AGRICULTURAL ENGINEERING for November, I was addressing a group from the North Atlantic states. I feel that I have some knowledge of wiring practices in this region, and in New York state in particular.

MORRIS H. LLOYD
Rural service engineer,
Buffalo, Niagara and Eastern Power Corp.

An Engineer's View of Land-Use Planning

(Continued from page 114)

manufacturer can in all probability meet these new physical requirements if agricultural returns justify the methods involved.

Here again it is economic, and as in all other things where engineering methods are involved, the greatest returns will come to those of highest managerial capacity. In the field of power and machinery, contributions will be felt most in the execution of a land-use program. If the pattern of development can be given general shape and direction, then the agricultural engineer should be in a position to render dynamic service through power and machinery applications.

Agricultural structures although a mobile influence may be studied more profitably from the static viewpoint, than power and machinery. The turnover in buildings is slow, and as a nation reaches maturity, this turnover should be slowed down even more. Land-use programs will influence structures more than structures will help to develop a land-use program. The concentration of production to the more favored areas will tend to stabilize farm populations, which in turn should make it possible to improve standards of construction, increase comfort, reduce fire losses, contribute to quality of products and improve processing methods. With this the necessity for utilities must not be overlooked. In the years ahead, with the stabilizing influence of a directional type of land-use program, rural sewer and water districts will materialize both from desire and necessity. These factors are worthy of considerable thought in a comprehensive land-use program.

Rural electrification is woven into the entire agricultural engineering fabric of soil conservation, power, machinery, structures, and utilities, and yet it has in itself a significant molding influence on rural development. Like power and machinery it is a dynamic factor. Energy in most every form will follow a wealth of natural resources. There is great mobility to electrical energy, and it has a decided influence upon rural life. Since its availability depends largely upon volume of use, land planning programs should contribute to more logical programs of rural electrical extension.

There are, of course, many other factors, some of which are engineering in nature, affecting land use. For the purpose of our Society, however, it seems wise to confine our initial efforts to those phases in which our Society has established leadership.

A Correction

AGRICULTURAL ENGINEERING for February 1936 (vol. 17, no. 2), the article entitled "An Absorptive Agent for Drying Grain," page 62—in the third from the last line in the last paragraph, the figure "8½" should have been used instead of "7½." The last sentence should read: "In case it has 18 per cent moisture and the drier would absorb 33½ per cent of its weight matter of water, approximately 8½ pounds would be required per bushel (60 pounds) of wheat to reduce the moisture content to 14 per cent."

The Division of Mechanical Equipment (BAE, USDA)

THE activities of the Division of Mechanical Equipment, Bureau of Agricultural Engineering, U. S. Department of Agriculture, under R. B. Gray, deal essentially with investigations in the field of farm power and machinery and are in all cases cooperative with federal or state agencies. Frequently cooperative relationships are established with farm machinery manufacturers.

The work of the Division may be divided into four general groups: (1) pest control, (2) fertilizer placement, (3) crop production methods, machinery, and equipment, and (4) power and machinery.

PEST CONTROL

This project does not include all of the pests which infest the realm of agriculture, but is limited to insect pests. It is an outgrowth of the European corn borer control work which was initiated in 1927. It is now centered at Toledo, Ohio, under the direction of R. M. Merrill. The research work has been responsible for the development of a number of machinery attachments, some of which are as beneficial to general farming as to the control of the corn borer, as, for instance, clean plowing, which, while one of the most practical corn borer mechanical control measures, is also an advantageous farm practice.

Mechanical attachments primarily designed for corn borer control developed by the Bureau include trash guide attachments for plows, self-angling disk jointers, downstalk lifting attachments for corn binders, and various low-cutting stalk shavers. A four-bar, side-delivery rake and an improved ensilage cutter which kills a high percentage of borers in infested stalks have also been developed.

The Division is doing some work in the mechanical control of the Japanese beetle, which is a menace to shade and ornamental trees, orchards, and nurseries, centered around Moorestown, New Jersey, under the direction of Frank Irons. A unique device has been developed to catch beetles on asparagus plants. Methods of applying soil insecticides for protection in nurseries is being investigated and two types of experimental machines have been devised.

At Presidio, Tex., D. A. Isler has for several years been working on means of controlling the pink bollworm of cotton. Cultural practice studies have shown that midwinter plowing following immediately by irrigation have, in most years, given excellent control. Here, too, experiments with dusting machinery are being carried on.

On account of the size and height of pecan trees, the mechanical control of the insect pests and fungus diseases of these trees requires special treatment which is being carried on by E. M. Dieffenbach at Albany, Ga. Mr. Dieffenbach has developed a focal plane shutter for studying spray patterns and is working on the development of spray guns for both high and low pressures which can be used effectively on pecans.

FERTILIZER PLACEMENT

The study of the placement of fertilizer in regard to the location of the seed is being carried on under the direction of G. A. Cumings under a wide variety of conditions with different crops and in different localities. This work includes a study of the effects of atmospheric moisture on drillability, efficiency, and uniformity of distribution in different machines and effects ot placement on germination, early plant growth, and yield. The Division has constructed twelve experimental machines by which fertilizer can be accurately placed in any desired position in regard to the seed. The work has progressed to the point where the trends are becoming quite evident. It is apparent that over a period of years approximately 20 per cent greater crop yields can be secured by proper placement than is generally secured by methods in ordinary use. The results in general indicate that placement approximately two inches to each side and two inches below the seed level has consistently been one ot the most superior methods of application. This study has stimulated the development of fertilizer-distributing machinery, and the next step is to arouse the interest of farmers in the proper placement of their fertilizer. It is hoped that the scope of this work may be broadened to include studies of corrosion-resistant alloys for use in certain parts of fertilizer distributors, the use of highly concentrated fertilizers, and fundamental studies of the movement of rain water in the soil as it affects the leaching of soluble fertilizer salts.

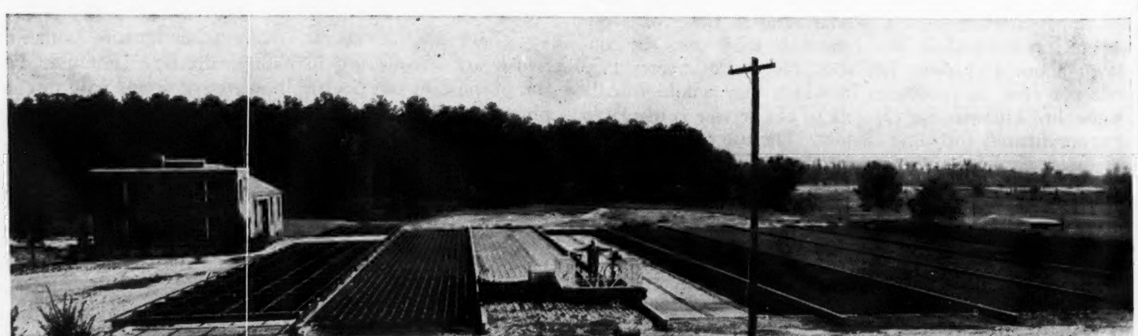
CROP PRODUCTION MACHINERY

This project has been designed to study the various phases of power and machinery and labor applications in growing field crops, but to date its intensive study has been limited to sugar beets, cotton, and corn.

In the sugar beet project, which is directed by E. M. Mervine at Fort Collins, Colo., and S. W. McBirney at Davis, Calif., investigations are aimed at reducing the need for hand labor now commonly used in cross-blocking, thinning, and harvesting. A mechanical cross-blocker has been developed which in one experiment showed a 30 per cent saving in the amount of labor required for this operation. Mechanical thinning is still definitely in the experimental stage, but a promising tool for that purpose is being developed. Studies made in cooperation with machinery manufacturers and beet growers have resulted in the development of a beet harvester which appears to be commercially acceptable. This outfit lifts and tops the beets, depositing them in piles on the ground. It is planned now to work out elevating equipment so that the beets may be loaded directly into a wagon.

Cotton production machinery studies have been devoted largely to a study of the effect of the mechanical treatment of the soil in seedbed preparation and cultivation on the tilth of the soil as measured by the crop yield. Some very interesting facts have been developed and the indications are that, on Greenville sandy loam soil at least, a minimum amount of seedbed preparation and cultivation gives a larger return than the more intensive work usually devoted to cotton production in that area. A variable depth cotton planter has been developed which tests show is very effective in securing seed germination, and is gradually coming into general use in the southern states.

The crop production work is closely allied to the work of the farm tillage machinery laboratory recently built at Auburn, Ala., and both projects are under the direction of John W. Randolph. The laboratory affords facilities for the study of the design of tillage *(Continued on page 122)*



THE OFFICE AND STORAGE BUILDING AND SOIL BINS OF THE FARM TILLAGE MACHINERY LABORATORY OF THE USDA BUREAU OF AGRICULTURAL ENGINEERING AT AUBURN, ALA.

NEWS

ASAE Annual Meeting Plans

PLANS of the Meetings Committee and the Committee on Local Arrangements are progressing satisfactorily in preparation for the 30th annual meeting of the American Society of Agricultural Engineers, to be held at the Stanley Hotel, Estes Park, Colorado, June 22 to 25, inclusive.

In addition to the program and other usual features characteristic of ASAE meetings, the meeting this year will offer unusual opportunity for sightseeing and vacationing. The following statement by Mr. E. M. Mervine, chairman of the local committee, on the recreation opportunities offered by the meeting this year, will be of particular interest to those who plan to attend the meeting:

"We want the members to start now planning for their vacation meeting, June 22 to 25, at Estes Park, Colorado—the Switzerland of America. Colorado is seven times as large as Switzerland and has six times as much mountain area. Rocky Mountain National Park, the eastern gateway of which is Estes Park, includes within its boundaries 405 square miles.

"The meetings will be held more than a mile and half above sea level, while the mountains themselves rise precipitously more than a mile above the park. Longs Peak, the highest of them all, rises 14,255 feet above sea level, practically the same height as the peaks of Switzerland, and it is one of forty-five other peaks in Colorado of similar height.

"Every member should come and bring his family since in camp they can live as cheaply as at home, or in a cottage they can have a vacation at a very nominal cost which they would long remember, or live in the meeting hotel reserved for our exclusive use at pre-season rates. Cost need worry no one.

"Mountain climbing, fishing, golf, bowling, horseback riding, entertainment for children of all ages, drives above the clouds or through canyons on safe and delightful highways in a climate where blankets are a comfort after the hottest day of summer.

"It is an ideal setting for a meeting, excellent facilities, beautiful surroundings, exhilarating climate, nominal costs; and plans are now well along for a good program."

A new idea will be tried out this year, for the purpose of enabling members to derive the greatest possible benefit from their attendance at the meetings. This plan provides for the making of arrangements in advance for members, on their way to and from Estes Park, to visit college agricultural engineering departments, federal and state research and demonstration projects, and the factories of manufacturers whose products are of particular interest to agricultural engineers. Announcements of plans and opportunities for such visits will be made from time to time between now and the meeting.

In order to provide more opportunity for individual contacts among members in formal group and committee conferences, etc., a new plan for holding regular meeting sessions will be tried this year. With the exception of the first day, the forenoon program each day will start off with a two-hour general session, followed immediately by separate or joint sessions of the technical divisions of two hours each. With this arrangement, the regular meeting sessions will close about 12:30 p.m., leaving the afternoon for informal committee and group meetings, sightseeing trips, etc.

The first half day of the meeting will be devoted to concurrent sessions of the College Division, National Student Branch, and other groups (not including the technical divisions) which may wish to schedule meetings during that period. The afternoon, as stated in the preceding paragraph, will be devoted to informal activities as desired and arranged by the members. There will be an illustrated talk of interest to members and their guests in the evening, and additional opportunity for informal group round tables arranged by members.

The first general session of the meetings will open at 8:30 a.m. on the morning of Tuesday, June 23, and the members and guests will be welcomed by Dr. Charles A. Lory, president of Colorado State College. At this session President L. F. Livingston will deliver the president's annual address, entitled "Agricultural Engineering Marches On." This session will also be featured by an address by Mr. Ralph E. Flanders, president of Jones and Lamson Machines Company, a recent past-president of the American Society of Mechanical Engineers, and a most ardent and able worker in behalf of the engineering profession.

The second period will feature concurrent sessions of the technical divisions, the arrangement and programs of which have not been definitely decided upon at this writing. The early part of the afternoon of the same day will be devoted to committee and group conferences, trips, etc., and the annual business meeting of the Society is scheduled for 4 p.m. The evening will be featured by illustrated talks, group round tables, and opportunities for recreation.

The program for Wednesday, June 24, will open with a two-hour general session in the morning, a feature of which will be an address, entitled "Looking Ahead in Agricultural Engineering," by Harry Bruce Walker, professor of agricultural engineering, University of California. The programs for the sessions of the technical divisions immediately following have not as yet been arranged. The afternoon will be devoted to informal activities of members featuring committee and group meetings, sightseeing trips, etc. And the feature which all members attending ASAE annual meetings look forward to with a great deal of interest, especially from the standpoint of relaxation and recreation—namely, the annual dinner—will be held in the evening.

At this writing it has not been finally decided whether or not there shall be another general session on Thursday, June 25, and decision on this point will depend largely on the amount of time needed by the technical divisions for their respective programs.

The chairman of the Meetings Committee and the various division chairmen will welcome suggestions from members for general and division programs to be presented at the Estes Park meeting. Additional information relative to the meeting will be gladly furnished from the office of the Secretary of the Society.

The American Society of Agricultural Engineers not only urges members, but also cordially invites non-members interested in our activities and program, to attend the meeting at Estes Park.

Washington News-Letter

FOLLOWING the annual meeting of American Engineering Council, reported in AGRICULTURAL ENGINEERING for February, the delegates and the executive committee, President A. A. Potter and the staff have reviewed the past activities of both committees and staff with the thought of giving a common sense of direction to both the delegates and the member organizations of the work for the year ahead.

The work of Council is carried out, first, through the agency of a paid staff at the Washington headquarters, and, second, by a group of committees, appointed annually by the president. Long standing policies of Council call for no new expression by committees, but the considered opinion of the members of Council is developed through the year by its several committees and provides the basis for staff action.

Last year, the committee on public affairs was organized in such a way that the chairman of subcommittees on questions of public moment became in fact the general committee on public affairs. The intent of these committees is to establish principles for the staff handling of details, and so successful was this plan that it received much commendation at the annual meeting. This year the same thought has been carried into the organization of committees in the other fields of action of Council, and the following plan has received the approval of the executive committee:

AEC committees have been divided into four groups, of which the first is the committees on public affairs for which the following subcommittees have been set up: (a) Aeronautics, (b) public works administration, (c) relation of engineers in private practice to government, (d) conservation and utilization of national resources, (e) patents, (f) surveys and maps, (g) regional activities, and (h) rural electrification.

ASAE Meetings Calendar

30th annual meeting—Stanley Hotel, Estes Park, Colorado, June 22 to 25, 1936.

A second group under a general chairman are committees on engineering and economic surveys. Under this head, the following subcommittees have been projected: (a) The balancing of economic forces, and (b) special studies.

The third group of committees combines the activities of earlier major and subcommittees and has been called committees on programs for united action of member organizations. Under this third group of committees, the following subcommittees have been approved: (a) Publicity for the profession, (b) economic status, (c) merit system in the public service, and (d) survey of the engineering profession.

It will be observed that three new committees ("a", "b", and "c") have been established. The object of these committees is to seek to coordinate for a common sense of direction activities now being handled in some cases by special committees of member organizations. The committees of Council are not to supplant the effective work of such committees, but rather to provide a common meeting ground for all those interested with the object of securing a larger accomplishment through collective action, wherever this is practicable. These committees grow out of the expressed wish of one or more members of Council to explore these fields for common action for the common good of the profession.

The fourth group of committees constitute the AEC operating committees and includes: (a) The executive committee, (b) finance committee, (c) membership and representation committee, (d) constitution and by-laws, and (e) publicity for American Engineering Council.

From time to time, the activities of these various committees will be reported in this news letter. In addition, it is proposed that the work of the public affairs committee and of the state and local public affairs committees, will be coordinated and expedited by a special news letter made up in part of the present "Engineering Embassy Service" and restricted, as now, to a limited list of officers and committee members of member organizations.

The general news letter, as now, will receive a wider distribution, especially through the cooperation of the editors of the publications of our member societies and of the general technical press.

* * *

Letters to the President of the United States and to the Secretary of the Interior have been written by President Potter of AEC, urging the appointment of an engineer-executive of high standing, as commissioner of the Bureau of Reclamation, a vacancy in the government service created by the sudden death of Dr. Elwood Mead. Assurances have been given that this post will be filled by a person of high capacity.

It should be made clear that Council has presented this case, not on the basis of recommendation of any specific individual, but on the consistent principle that administrative positions in the government should not be filled by political appointees. It should further be stated that this action of Council is not only in line with past policy of Council, but upholds the principle of the merit system in public service.

In this connection, one of the most constructive thoughts expressed regarding efficient government administration on the occasion of the 53rd anniversary of the civil service came from Mr. Harry B. Mitchell, president of the Civil Service Commission of the United States. In substance, he said that the determination of policy—what the government shall do—is a separate function and should be placed in the hands of those officers who usually change after an election. On the other hand, he stated, competent administration demands continuity of service carried on by well-trained employees who know what steps to take to put those policies into action.

Evidences accumulate that the policies advocated by Council during the past year relative to the practical methods of expenditure under various emergency appropriations, are gaining ground in Washington.

The Division of Mechanical Equipment

(Continued from page 120)

tools with respect to the various soil types and the effect of various types of tillage tools upon the tilth of the soils. It is hoped to tie the laboratory experiments up with corresponding field investigations on similar soil types. It is planned to make the facilities of the laboratory available to the manufacturers of farm machinery, so far as possible, for cooperative work in solving tillage equipment and machinery problems.

Corn production studies are similar in purpose to those of the cotton production project and are conducted under the supervision of C. K. Shedd at Ames, Iowa. The immediate objectives are to improve the technique of use and management of labor, power, and machinery to obtain information for better selection of available machines to accomplish the necessary work and to develop new and modified machinery and methods of culture and harvesting which will be more economical in labor, power, and machinery expenditures. Among the specific accomplishments are two methods of improving check rowing with four-row planters; the development of auxiliary snapping rolls for a corn picker, which, in preliminary tests, has shown 80 per cent reduction in the loss of shelled corn as compared with standard rollers; and the development of wagon hitches and telescoping wagon tongues which seem to promise a 25 per cent saving in the labor of transporting corn from picker to storage.

POWER AND MACHINERY

This project is carried on by W. M. Hurst from the Washington office and covers a variety of studies on the use of farm equipment. Considerable work has been done on seed cleaners for removing smut balls and on various methods of treating seed. A device for metering out fungicides used in treating small grain has been developed. A single-row cotton stripper has been altered for use in harvesting soybeans, and the same machine was used to good advantage in harvesting pyrethrum flowers during the past season. A study of the operation of small combines during the past harvest season in soybeans and small grain have indicated that small machines can perform equally as well as the large ones. For some years past the Division has been carrying on studies of forage drying at Jeanerette, La. This work has been successful in demonstrating the feasibility of artificially drying forage under southern conditions and that the artificially dried forage is not inferior, as a food for livestock, to the naturally dried forage, but it has not been successful in developing an inexpensive method of drying forage and is being discontinued on March first.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the February issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Harlon H. Backhaus, technical foreman engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Manly, Iowa.

Elmer F. Brunner, development engineer, in charge of tractor and implement sales, Goodyear Tire & Rubber Co., Akron, Ohio. (Mail) 81 Hastings Road, Silver Lake, Cuyahoga Falls, Ohio.

Frank Y. Duncan, assistant engineering aide, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Spartanburg, S. C.

Harold L. Geiger, metallurgical engineer, International Nickel Co., Chicago, Ill. (Mail) 2408 E. 78th St.

Russell I. Griffith, drainage engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Whiting, Iowa.

G. W. Grisdale, Jr., agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 18, Lebanon, N. J.

Harold W. Hobbs, associate agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) RFD No. 3, Bath, N. Y.

J. H. Johns, Jr., under-engineering aide, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Spartanburg, S. C.

Sylvester H. Keller, junior technical foreman, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Mankato Hotel, Mankato, Kansas.

Frank M. Mason, farm service agent, Detroit Edison Company. (Mail) 111 Smith St., Mount Clemens, Mich.

Neal G. Preston, camp engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Camp Garfield SCS-W5, Pomeroy, Wash.

Herman Schildknecht, agricultural and civil engineering (chief state engineer) professor of irrigation, Kantonales Kulturingenieurbureau, Hergiswil, Kantonales Bauamt, Stans, Eidg Technische Hochschule, Zurich. (Mail) Hergiswil, Nidwalden, Switzerland.

H. C. Stevens, assistant county agent, Coffey County Farm Bureau, Burlington, Kans.

R. E. Wilkin, manager, technical and automotive departments, Standard Oil Co., 910 South Michigan Ave., Chicago, Ill.

Thomas G. Young, farm implement tire sales, Goodyear Tire & Rubber Co. (Mail) 1770 York Ave., Memphis, Tenn.

TRANSFER OF GRADE

W. A. Harper, in charge of test farm, Caterpillar Tractor Co., Peoria, Ill. (Associate to Member)

John G. Sutton, district engineer (ECW camps), central district, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Box 755, Milwaukee, Wis.

Personals of ASAE Members

Wallace Ashby, chief, division of structures, Bureau of Agricultural Engineering, U. S. Department of Agriculture, is one of the authors of Farmers' Bulletin No. 1749, entitled "Modernizing Farm Houses," just published.

E. E. Brackett, professor of agricultural engineering (and head of the department), University of Nebraska, was recently elected president of the City Engineers' Club of Lincoln.

C. T. Bridgman has been appointed engineer for the Clay Products Institute, 418 Hubbell Building, Des Moines, Iowa, and will be engaged in research and engineering work in connection with the use of structural clay tile products. More recently he was research fellow in agricultural engineering at Iowa State College.

R. B. Hickok has been appointed associate agricultural engineer in the section of watershed and hydrological studies in the division of research of the USDA Soil Conservation Service, and is located at Coshocton, Ohio.

Truman E. Hienton, agricultural engineer, Purdue University Agricultural Experiment Station, is author of Circular No. 187 (Second Revision), entitled "Electric Brooders on Indiana Farms," recently issued.

Walter C. Hulburt has been appointed instructor in agricultural engineering, University of Arkansas, Fayetteville.

O. W. Israelsen, irrigation and drainage engineer, Utah Agricultural Experiment Station, and *W. W. McLaughlin,* chief, division of irrigation, Bureau of Agricultural Engineering, U. S. Department of Agriculture, are joint authors of Bulletin 259, entitled "Drainage of Land Overlying an Artesian Ground Water Reservoir," just issued by the Utah station.

H. F. McColley, agricultural engineer, North Dakota Agricultural College, is author of Circular 58, entitled "Homemade 6-Volt Wind Electric Plants," and joint author of Bulletin 283, entitled "The Pen Barn and Separate Milking Room," just issued.

Otis E. Smith has been appointed as an agricultural engineer of the USDA Soil Conservation Service, with headquarters at Graceville, Florida.

H. J. Stockwell has been appointed assistant county farm agent of Atchison County, Kansas. He was formerly connected with a CCC project at California, Mo. New address is Effingham, Kansas.

Clarence F. Vogel, more recently a field representative (agricultural engineer) of the Federal Emergency Relief Administration, is now a member of the advertising department of the J. I. Case Company, Racine, Wis.

D. S. Weaver is on a year's leave of absence from North Carolina State College to do special work in rural electrification for the USDA Extension Service in the capacity of extension specialist in rural electrification and liaison for the Rural Electrification Administration.

WHAT IS NEW
in Agricultural Engineering

FROM THE USDA BUREAU OF AGRICULTURAL ENGINEERING

IN CONNECTION with experimental work in evaporation from water surfaces at La Verne, Calif., A. A. Young reports that evaporation in a covered reservoir showed the lowest rate during the hot month of August when the outside evaporation was the highest. From August to December inside evaporation increased from 0.9 to 2.5 inches per month, the latter amount equal to the loss from an uncovered pan.

J. G. Sutton, who is supervising the work of the 36 CCC drainage camps located in the central states, reports that arrangements have been completed whereby the drainage districts with which the camps are cooperating will furnish, free of cost to the camps, 52 drag-line machines to be operated by the camp personnel on ditch maintenance work. In addition to the drag-line excavators, the districts are also purchasing materials required to repair various types of structures and numerous tractors and teams for use on the smaller ditches. During the past three months the cash value of the cooperation thus furnished has averaged over $20,000 per month. Such cooperation indicates that the work of the camps is appreciated by the local people.

J. T. Olsen reported to the Washington office for duty as assistant drainage engineer January 21. He has been assigned to administrative work in the Division of Drainage. Prior to joining the staff of the Bureau, Mr. Olsen was an engineer appraiser for the Federal Land Bank at Louisville, Kentucky. He is a graduate of Iowa State College and has had 15 years experience in drainage work.

David S. Weaver has secured a year's leave of absence from North Carolina State College at Raleigh to serve the Bureau as extension specialist in rural electrification. Cooperating with the Rural Electrification Administration, he will carry rural electrification information to the extension services and agricultural engineering departments of the various states. Secretary Wallace has recently appointed Mr. Weaver secretary of the newly formed national farm committee to advise with Morris L. Cooke, Rural Electrification Administration, on agricultural policies in connection with the rural electrification program.

In connection with cooperative experimental work at the Belle Glade, Fla. Experiment Station, B. S. Clayton reports that the total evaporation and transpiration losses during 1935 on tank experiments were as follows:

Cane tank No. 1—46.51 inches
Cane tank No. 2—46.55 inches
Bare soil tank No. 3—39.15 inches (partly shaded)
Alfalfa tank No. 4—45.11 inches (poor stand of alfalfa)
Open pan—70.57 inches
The rainfall was 48.81 inches.

Tests of temperature, humidity, and air movement in farmhouses were started by M. J. LaRock, at Madison, Wis. This is one phase of a study being undertaken by the Division of Structures in cooperation with the experiment station of the University of Wisconsin. This information should disclose the best method of improving farmhouses so as to increase the comfort of the occupants.

The study of corn pressures in cooperation with the Ohio State University has shown the following results, as reported by J. R. McCalmont who conducted the tests: In a crib 6 feet wide, with cross braces 10 feet apart, the floor supported 72, 58, and 44 per cent, respectively, of the total load when there were 8, 16, and 24 feet of corn in the crib, while in a crib 8 feet wide with cross braces 6 feet apart the floor loads were 79, 57, and 46 per cent, respectively. The height-width ratio of the 6-foot crib was 4 to 1. Unit pressures on the walls and floor appear to have reached almost their maximum values, indicating that in cribs of greater height-width ratio, the additional load would be carried largely by friction on the crib walls and/or cross braces.

The Division of Irrigation is now conducting the first of its snow surveys in the Rocky Mountain states for the purpose of forecasting the amount of irrigation water which will be available for the coming season. Many of these snow courses are in the high mountains, and the work of securing the necessary snow samples involves some very strenuous work, and there is always the possibility of hardship and serious danger. The final observations will be made about March 1 and the forecasts prepared at that time. This work is being carried on in cooperation with various state and federal agencies.

The following bulletins have been issued during the month:

Modernizing Farmhouses. Farmers' Bulletin 1749.
Roof Coverings for Farm Buildings and Their Repair. Farmers' Bulletin 1751.
Utilization and Cost of Power on Mississippi and Arkansas Delta Plantations. Technical Bulletin 497.

Ohio Has Curriculum in Agricultural Engineering

THE council of instruction at Ohio State University approved last July a five-year curriculum in agricultural engineering. The student takes his basic agriculture and basic engineering the first four years and fulfills all the requirements for a degree of bachelor of science in agriculture. The fifth year is taken in the college of engineering, and at the completion of the work he receives the degree of bachelor of agricultural engineering from the college of engineering.

The curriculum is jointly administered by both colleges. This year 15 students are taking the five-year curriculum, and two students who had pursued this curriculum before it was officially established, were elected to Tau Beta Pi this spring quarter.

The agricultural engineering staff at Ohio State reports that the new curriculum has been well received by the students, and they are especially pleased with the fine spirit of cooperation that exists between the colleges of agriculture and engineering in the administration of the curriculum.

Ohio Student Branch News

THE Student Branch of the American Society of Agricultural Engineers at Ohio State University has been very active this year in executing their proposed plan of work. The Branch has grown to where it now has about 35 members.

The first meeting in 1935 was devoted to outlining our objectives for the year. Then, in order to carry them out, we classified our activities according to the objectives which they would fulfill. After we analyzed our program in this manner, committees were appointed to cover each phase of the work which might arise as a result of carrying out any part of the program.

Our following meeting was in the form of an open house to which everyone interested was invited. Several stunts and talks concerning our organization were presented to the large group by officers of the Branch and faculty members of the agricultural engineering department. Following the meeting, cider and doughnuts were served and applications for membership taken. Several new members signed up.

Each year we operate a cafeteria during Farmers' Week in Ives Hall, the agricultural engineering building. This year we were again quite successful for we took in approximately $635 from plate lunches and short orders. The accompanying picture shows a few of the hundreds of people who passed by the counter during the midday rush on one of the five days our place of business was in operation. Our cafeteria is alway conducted in a businesslike manner with all problems and details of management outlined beforehand by various committees. As a result, the set-up functions smoothly, for each person in the organization knows what his duties are.

The proceeds are used to send delegates to the ASAE annual meeting, and to cover miscellaneous costs of operating the Branch.

For several of our meetings this year Professor G. W. McCuen, head of the department of agricultural engineering here, has shown movies taken during his trip abroad last summer. From his lectures and pictures we have learned much concerning European agriculture.

Occasionally we have an outside speaker or several reels of movies from a local implement company.

For our next meeting we are having Mr. E. A. Silver, the faculty adviser for our Branch, and Dr. A. F. Schalk from the college of veterinary medicine talk and show moving pictures of their recent investigations in experiments with digestion in cattle.

In the near future we expect to take a trip to some point of interest to the group, probably a factory. Last year we went to Akron, the rubber city, and were shown through the Goodyear factory while it was in operation.

Just recently the Branch proposed to publish regular news letters for the benefit of the graduates who were former members. The first one is now ready to be issued.

We are also keeping an up-to-date record of all alumni from the agricultural engineering department which includes their location and occupation.

Towards the close of the Spring quarter plans will be completed for a banquet at which time the new officers for the coming year will be installed.

A five-year curriculum is now available to students who desire to take work leading to the degree of bachelor of agricultural engineering. Seventeen students are now registered in this curriculum.

This makes us eligible for representation on the Engineer's Council, and, as a result, two representatives from our Branch have been appointed to serve on this Council.

So far we feel that we have made this year outstanding in the Branch's history, for plans are not only being made, but they are being carried out.

Our officers this year are: E. A. Silver, faculty adviser; Glenn Foltz, president; Harris Gitlin, vice-president; and Paul Rofkar, secretary and treasurer. Probably much of the success can be traced directly to these officers' capability.

From now on our biggest objective will be to send a representative number of our men to the Estes Park (Colo.) meeting of the Society next June.—Myron Martin, chairman of Publications Committee

Missouri Student Branch News

AT A recent meeting of the Missouri Student Branch of the American Society of Agricultural Engineers, officers were elected for the second semester of the current school year as follows: Glen Pittenger, president; Ralph Ricketts, vice-president; Robert Beasley, secretary-treasurer; and Joe Park, scribe.

Idaho Student Branch News

ON DECEMBER 7 the Idaho Student Branch of the American Society of Agricultural Engineers entertained the members of the Washington Branch from Pullman. Topics of interest to both groups were discussed. Several motion picture films were shown, including a Diesel engine development and other shorter subjects. A dinner was served to complete the day's activities. About twenty-five members were present.

January 7 was a big day for the Idaho Branch when the ASAE president, Mr. L. F. Livingston, gave a speech before the associated engineers. His talk on the utilization of farm products in the manufacturing industry has created much interest in the subject. All engineers and others who heard it enjoyed it exceedingly. Several of the Idaho boys travelled to Pullman, Washington, the same evening to hear Mr. Livingston's speech again at a banquet. The agricultural engineers are fortunate in being represented by Mr. Livingston, and the group benefitted greatly by his visit.

A new publication, "The Idaho Agricultural Engineer," will be printed soon. Each member has contributed a short article to make the publication representative of the whole branch. This undertaking is the first of its kind by our group; other additions will follow as a regular activity.

Tentative plans are being made for a trip to Oregon State College some time next spring, when it is proposed that the Washington State and Idaho branches travel together and make the meeting a Northwest Conference of ASAE Student Branches.—William Watson, scribe

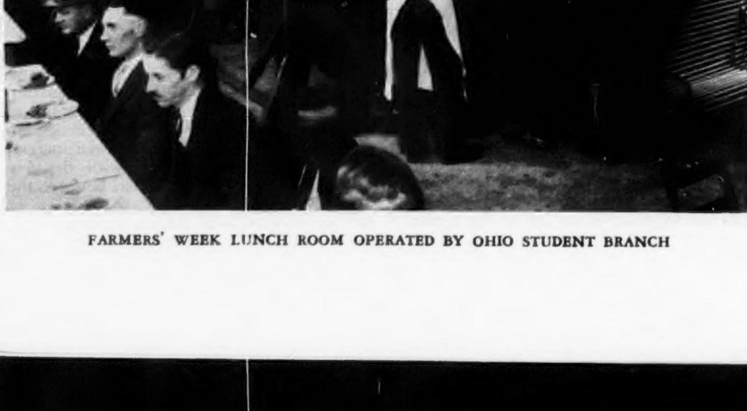
Virginia Student Branch News

THE ASAE Student Branch at Virginia Polytechnic Institute began the new school year with increased interest and enthusiasm. The membership has increased to 38 members as compared with an enrollment of 20 last year. Under the leadership of our faithful president, C. T. Savage, the organization has been striving throughout the year toward increasing the interest and activity of the members.

Regular meetings have been held every Thursday night throughout the year, at which time junior and senior members gave talks on subjects of interest to agricultural engineers. At a special meeting sound pictures, entitled "Farmall Tractor in Operation," and "The Story of Binder Twine," were presented by the International Harvester Company of Richmond under the direction of Mr. E. W. Davis. At two social meetings outside speakers were present.

By means of PWA funds a new $20,000 laboratory is being built solely for agricultural engineering purposes. This building is the first unit of our proposed $150,000 building.

The club regrets the loss of its former course adviser, V. R. Hillman, who is now connected with the Soil Conservation Service. Professor Hillman has been replaced by a former president of this Branch, S. H. Byrne, who is very much interested in the work we are trying to do. Under the guidance of Mr. Byrne the club has planned a very interesting program for the future months.—A. M. Brown, scribe



FARMERS' WEEK LUNCH ROOM OPERATED BY OHIO STUDENT BRANCH

is PRICELESS –

He is the American Farmer

A MAN named Niebel was among the first to grab a musket when the revolution started. Afterwards, when George Washington disbanded his ragged victors, Niebel went west into Ohio in a covered wagon. His oxen cleared the land where Henry County Court House now stands.

When horses displaced oxen for farming, Niebel was the first to import a team.

When the day of the tractor dawned, it was to the Niebel place that farmers came to see a tractor at work . . . his grandson, Elmer Niebel, had bought one of the outlandish things.

Last year, in January, 1935, Elmer Niebel looked at some blue-prints, took home a typewritten set of specifications to study—and placed his order for the first high-compression tractor sold in America.

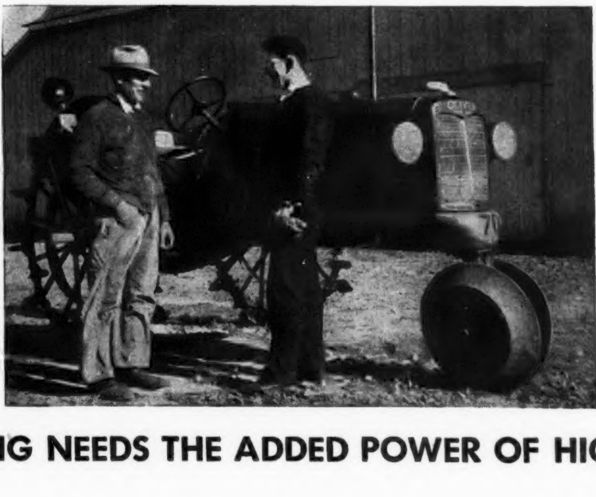
It was a tractor designed without compromise—designed not for "any kind of fuel," but for *one fuel*—designed for *efficiency* and *economy*—not to straddle *in*efficiently and *un*economically the possible use of good gasoline, poor gasoline, kerosene and distillate in one engine.

Elmer Niebel was the first to buy that tractor—it hadn't yet been named. Since then it has been christened the Oliver "70" after the 70 octane, regular-priced gasoline for which it was designed. Today thousands of those tractors are already at work throughout the country—smashing previous records for cost per hour and cost per acre—giving farmers lower costs and better incomes—and cementing more priceless good will to the century-old firm of Oliver.

Since Mr. Niebel bought his tractor, other progressive tractor engineers are designing high compression tractors to take advantage of the high quality of regular-priced gasolines now being sold by leading oil companies in every state . . . designing high compression engines to gain the rewards of *greater power . . . increased torque . . . lower maintenance cost . . . better fuel economy . . . longer engine life . . . lower exhaust gas temperatures . . . less waste heat to cooling water . . . and the elimination of wasteful crankcase dilution.*

Some other companies are already marketing high compression tractors. Still others will be announced—but these pages are published as a tribute to two pioneers: The Oliver Farm Equipment Company and Elmer Niebel — first to make, and first to buy, the tractor of tomorrow.

Ethyl Gasoline Corporation, Chrysler Building, New York City, manufacturers of anti-knock fluids for premium and regular gasolines.



• *Elmer Niebel, left, and George Von Deylen of the firm of Von Deylen-Wiemken, Oliver dealers in Napoleon, who sold the first Oliver "70."*

MODERN FARMING NEEDS THE ADDED POWER OF HIGH COMPRESSION

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

WATER UTILIZATION IN THE SNAKE RIVER BASIN, *W. C. Hoyt.* U. S. Geol. Survey, Water-Supply Paper 657 (1935), pp. X÷379, pls. 26. Information is presented on water use in the Snake River Basin which comprises about 109,000 square miles of river, plain, foothills and mountains.

DAIRY PLANT EFFICIENCY STUDIES. Vermont Sta. Bul. 396 (1935), p. 23. Supplementing Bulletin 388, data are reported as to the accuracy of a wabble-disk milk meter.

IOWA ACTIVE IN RURAL ELECTRIFICATION. Elect. World, 105 (1935), no. 19, pp. 41, 69). A brief description is presented of the rural electrification activities at Iowa State College, with particular reference to those which are being done in cooperation with the Rural Electrification Authority.

DISINFESTING SOILS BY ELECTRIC PASTEURIZATION, *A. G. Newhall* and *M. W. Nixon.* [New York] Cornell Sta. Bul. 636 (1935), pp. 20, figs. 10. This bulletin reports the results of studies of electricity as a source of heat and of an intensive investigation of two general types of portable electric soil sterilizers. One of these sterilizers employs the soil-resistance principle in which the current passes directly through the soil; the other employs the heating-element principle in which the current passes through resistance heating units properly spaced to impart their heat to the soil by thermal conductance. Both types were found capable of destroying a number of common pathogenes, including bacteria, sclerotial fungi, nematodes, and weed seeds.

Evidence is presented to show that it is not necessary to raise soil temperatures above 70 degrees (Centigrade) in the presence of adequate soil moisture to kill several common soil pathogenes. All kinds of soils from pure sand to pure muck were effectively treated in both types of pasteurizer. However, in the direct-heating or resistance type it was often necessary to add some dilute electrolyte solution to sand to insure heating in a reasonable time.

In comparison with other standard methods of soil or seed treatment for damping-off control, electric pasteurization appeared to be equal to the best.

The current consumed per cubic foot per degree rise varied with different kinds of soil (22 or 23 watts for a pure sand with its comparatively low water content and 27 or 28 watts for muck with its comparatively high water content). In general, a 50-degree rise in temperature (from initial 20 degrees to final 70 degrees) required from 1.0 to 1.3 kilowatt-hours. Where only nematodes and damping-off organisms are being combated, lower final temperatures are permissible, at a saving of current, if more time is employed.

A certain minimum initial-soil-moisture content was found to be very important for most effective operation of both types of pasteurizer. Factors affecting the uniform temperature rise in different parts of the soil mass included uniform distribution of soil moisture, position in the box, degree of packing, insulation, intimacy of contact with electrodes, and speed, or time.

Each type of pasteurizer has its distinct advantages and disadvantages, the sum total of which perhaps favor the second type for general use by the average operator because of its greater safety and simpler operation. So far, attempts to disinfect benches and ground beds with ordinary soil-heating cable have not been successful.

TIMBER FOR STRUCTURAL USES: ITS DESIGN, WORKING STRESSES, AND PRESERVATIVE TREATMENT, *W. H. Greene.* Engin. Jour., 18 (1935), no. 9, pp. 409-412, figs. 7. This is a brief technical statement relating to features of structural timber design and preservative treatment.

SELECTION OF LUMBER FOR FARM AND HOME BUILDING, *C. V. Sweet* and *R. P. A. Johnson.* U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1935, pp. [2] + 55, figs. 16. The purpose of this mimeographed publication is to assist in the estimation of the essential requirements for different building purposes, to show how the different kinds of woods meet these specific requirements, and to emphasize principles that should be followed in good construction. Information is given on classification of woods according to important properties, lumber grades and sizes, standard lumber items usually carried in retail yards, and important points in construction and maintenance.

THE REFRIGERATED GAS-STORAGE OF APPLES, *F. Kidd* and *C. West.* [Gt. Brit.] Dept. Sci. and Indus. Res., Food Invest. Leaflet 6 (1935), pp. 12, fig. 1. British practice in the refrigerated gas storage of apples is described. Information is presented on the prestorage treatment of the fruit and on how to develop the storage itself. Appendixes are included on recommended temperatures and atmospheres for the storage of homegrown apples and on the cost of gas storage.

1934 TRACTOR COSTS IN MICHIGAN, *K. T. Wright.* Michigan Sta. Quart. Bul. 18 (1935), no. 1, pp. 49-53. Data are presented on the cost of operation of 66 tractors during 1934.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE DEPARTMENT OF AGRICULTURE, *A. T. Mitchelson, C. E. Ramser, C. S. Scofield, M. W. Hayes, R. V. Allison, J. W. Randolph, I. F. Reed,* and *R. R. Drake.* U. S. Dept. Agr. Yearbook 1935, pp. 167, 168, 184-187, 236-238, 289-291, 299-305, 313-315, 342-344, figs. 11. Progress in the following lines is summarized: Replenishment of depleted ground water by artificial spreading, disposal of runoff water as an essential in erosion protection by terracing, drainage of irrigated lands to correct excessive salinity, river gage work to improve flood forecasting, soil erosion, tillage machinery, and wind erosion control by tillage.

BURGLAR-PROOFING THE FARM, *H. N. Colby.* N. H. Univ. [Agr.] Ext. Circ. 171 (1935), pp. 15, figs. 10. This bulletin describes several methods of farm protection by use of electrical alarm systems, with particular reference to the needs of poultrymen.

A PRELIMINARY REPORT ON THE RESPONSE OF THE EUROPEAN CORN BORER TO LIGHT, *G. E. R. Hervey* and *C. E. Palm.* Jour. Econ. Ent., 28 (1935), no. 4, pp. 670-675, figs. 3. In work at the New York State Experiment Station light traps of the type tested and under the conditions governing the experiment reported appear to have little value in protecting sweet corn from the European corn borer. Substantial moth catches were made over a period of 42 days and over half of the specimens were females. The infestation developing in the experimental fields, however, was apparently an average infestation for that general area.

The traps appear to have value as a means of studying the habits of the insect, particularly the period of flight, flight habits, and the effect of weather conditions on the activities of the moths. It is possible that with a different arrangement and number of lights or a different light source the moth population in the field might be lowered sufficiently to reduce the normal larval population. However, the number of moths captured under the conditions of the experiment reported here must have represented only a small part of the moth population of the field.

MANUAL ON PRESERVATIVE TREATMENT OF WOOD BY PRESSURE, *J. D. MacLean.* U. S. Dept. Agr., Misc. Pub. 224 (1935), pp. 124, figs. 35. The purpose of this publication is to discuss the application of the results of numerous experiments and observations conducted by the Forest Products Laboratory at commercial treating plants to the improvement of the pressure treatment of wood and to present general information on the subject for use particularly by engineers.

Information is given relating to pressure processes; wood preservatives; effect of wood structure on treatment; moisture content, specific gravity, and air space in wood; preparation of timber for treatment; injecting preservatives; absorption and penetration; effect of treatment on the physical condition of wood; bleeding of treated wood; treating conditions used in commercial practice; and specifications for treatment.

Formulas are given (1) for computing relation of moisture content, specific gravity, and air space in wood, and (2) for computing temperatures in timbers when the temperature of the heating medium, the wood temperature, or both, are different from those in green timbers. *(Continued on page 130)*

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TRACTION ALL WAYS

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REMOVING SMUT BALLS FROM SEED WHEAT, *W. M. Hurst, W. R. Humphries, R. W. Leukel,* and *E. G. Boerner.* U. S. Dept. Agr. Circ. 361 (1935), pp. 16, figs. 6). This report represents the results of studies which were conducted cooperatively by the USDA Bureaus of Agricultural Engineering, Plant Industry, and Agricultural Economics. A study was made of the possibilities of a number of grain-cleaning devices.

It was found that smut balls are usually lighter and, in some cases, smaller than the kernels of wheat in which they are found. Tests made with both experimental and stock farm-sized cleaners showed that wheat may be exposed to air blasts of sufficient intensity and in such manner as to blow out all smut balls from the grain. Some smut balls may also be screened out, but screens are not so effective as air blasts.

Grain cleaners of the fanning-mill type were found to be more effective in removing smut balls from wheat than other types of cleaners on which tests were made. A blast of air directed upward against a stream of falling grain was found to be more effective in removing smut balls, especially at low air velocities, than when striking the stream at right angles. Generally, the best results in removing smut balls were obtained when the fanning mills were run at considerably less than their rated capacities.

THE CLAY RATIO AS A CRITERION OF SUSCEPTIBILITY OF SOILS TO EROSION, *G. J. Bouyoucos.* Jour. Amer. Soc. Agron., 27 (1935), no. 9, pp. 738-741. In a contribution from the Michigan Experiment Station the sand-plus-silt-to-clay ratio is suggested as a possible criterion for judging the relative susceptibility of soils to erosion. This ratio is designated as the clay ratio. It was compared with the erosion ratio by using the same soils and the same mechanical analysis of these soils as reported by the USDA Bureau of Chemistry and Soils. The comparison showed that with few exceptions the two ratios agreed fairly well in indicating the general susceptibility of soils to erosion.

EXPERIMENTS WITH CURING ALFALFA HAY, *H. C. Rather* and *R. H. Morrish.* Michigan Sta. Quart. Bul., 17 (1935), no. 4, pp 212-219, figs. 3. Comparisons of several curing practices with alfalfa hay, 1932-34, showed that the curing of alfalfa in the swath is unsatisfactory, swath-cured alfalfa always being lowest in protein content. The ground from which such hay was raked was coated with shattered leaves and the hay was stemmy and brittle and appeared faded or bleached. Alfalfa windrowed 24 hours after cutting likewise lost considerable leaves and generally was lower in protein, although the loss was not always serious. Hay cured in cocks was satisfactory in quality, usually having a slight advantage in protein content, but this curing method required extra labor to build the cocks and materially longer to dry the hay down enough for storage. Raking the hay soon or within a few hours of cutting and curing in windrows was the most practical curing system tested. Practical suggestions for curing in cocks on small acreages and windrowing for large acreages in dry and wet weather are outlined.

THE USE OF AN EVAPORATION INDEX IN WATERING LAWNS, *J. D. Wilson* and *F. A. Welton.* Ohio Sta. Bimo. Bul. 174 (1935), pp. 112-119, figs. 2. In further tests in 1934 on Kentucky bluegrass lawns, the plat receiving 1 inch of water (about 620 gallons per 1,000 square feet, or 27,000 gallons per acre) every time the Livingston black atmometer lost 320 cc of water, without a rain of 0.5 inch or more intervening, showed the best or most uniform growth of grass as compared with 240 and 400 cc evaporation increments. The water received by this plat (rainfall + irrigation) totaled 27.69 inches from May 1 to August 31 inclusive, or 1.8 times normal rainfall for the period and 3.75 inches more than evaporation from a free-water surface. Indications were that at Wooster, lawns need water during summer somewhat exceeding that lost by evaporation from a free-water surface during the same period and about 75 per cent more than normal rainfall. Thus, the addition of the extra inches of water over those falling as rain (12 + (normal — actual rainfall), which will vary somewhat from year to year with the evaporation) can be regulated efficiently as to time and quantity by the use of an evaporation index corresponding to a loss of 320 cc of water from a Livingston, standardized black atmometer. This insures application of water before growth is checked because of soil-moisture deficiency, or about 4 or 5 days before the grass is visibly injured.

ELECTRICAL COOKERY, *M. M. Monroe.* Maine Sta. Bul. 377 (1934), pp. 407-409. This progress report describes briefly the baking performance of small, inexpensive, noninsulated, low wattage electric ovens, and discusses conditions under which these may be used to greater advantage than the regular range oven.

FUNCTIONAL DISEASES OF THE APPLE IN STORAGE, *H. H. Plagge, T. J. Maney,* and *B. S. Pickett.* Iowa Sta. Bul. 329 (1935), pp. 33-79, figs. 28. On the basis of their long continued studies, the authors describe, illustrate, and clearly point out for the benefit of growers, dealers, and others the differences between various nonparasitic disorders of apples met with in storage. Brief accounts are given of conditions influencing the diseases, and methods of control are outlined. Apple scald, Jonathan spot, mealy breakdown, soggy break-down (embracing soft scald), brown heart, internal browning, water core, bitter pit, freezing injury, and cork and drought spot are included. *Penicillium* soft rot is also described.

Suggestions for handling and storing apples and discussions of picking maturity, storage temperature, storage humidity, and duration of storage are given. The differences of various apple varieties in their behavior relative to these disorders and to storage conditions are brought out.

For cold storage about 36 degrees F, with 90 per cent relative humidity, proved optimum in 10-year tests, particularly where oiled paper was used to control scald. At the temperature mentioned less soggy break-down occurred than at 30 and 32 degrees.

SIMPLE AND RAPID METHODS FOR ASCERTAINING THE EXISTING STRUCTURAL STABILITY OF SOIL AGGREGATES, *G. J. Bouyoucos.* Jour. Amer. Soc. Agron., 27 (1935), no. 3, pp. 222-227. An investigation carried out at the Michigan Experiment Station has shown that potassium chloride has a marked effect in contracting the volume and decreasing the water-holding power of deflocculated soils. These phenomena were utilized in studying the structural stability of soil aggregates by measuring their settled volume and moisture equivalent after treatment with a normal solution of KC1.

"From the experimental results obtained, the soils examined group themselves into three classes in respect to their existing aggregate structural stability. Class 1 contains soils which reveal a stable existing aggregate structure. In these soils the KCI treatment produces no change in their settled volume and moisture equivalent, but they remain the same as with the water treatment. Class 2 comprises soils which reveal an unstable existing aggregate structure. In these soils the KC1 treatment tends to reduce markedly both the settled volume and moisture equivalent. Class 3 represents soils which show only a moderately unstable existing aggregate structure. In these soils the KC1 treatment reduces the volume and moisture equivalent to a varied but moderate degree.

"Both the settled volume and moisture equivalent always ran parallel and agreed with one another in every soil. This fact indicates that both of these methods give reliable results."

SOME CHEMICAL AND PHYSICAL PROPERTIES OF NORMAL AND SOLONETZ SOILS AND THEIR RELATION TO EROSION, *H. F. Murphy* and *H. A. Daniel.* Soil Sci., 39 (1935), no. 6, pp. 453-461. Data obtained in an investigation of the Oklahoma Experiment Station indicated a relatively high rate of erosion, especially after the loss of the A horizon, in certain solonetz soils.

The high erosion rate is considered to be due largely to a high dispersion coefficient, but "the high dispersion coefficient of the B horizon of the solonetz soils is not the only reason for their rapid erosion. Such areas are usually devoid of, or support only a sparse, vegetative growth, and hence there is no buffer against the agitation of raindrops, as there is on the normal soils where the vegetation may offer considerable protection not only in this manner but also because of extensive root development. This not only applies to the solonetz soils where the B horizon is exposed but to those which have been under cultivation at some previous time and when only a thin A horizon remains. This thin A horizon is usually not capable of supporting a vegetative covering that will offer much protection to the soil, and, since rain water cannot penetrate the lower horizons, this thin horizon soon becomes supersaturated with water and erodes away rapidly when it occupies sloping areas. Although the clay content is usually somewhat higher, the high active sodium content and the low calcium-sodium ratio of the exposed B horizon of the solonetz profile readily account for the high dispersion coefficients of these eroded areas compared with the surface soil and the normal profile. . . .

"The replaceable sodium is high in the B horizon of the solonetz profile. It appears that where the replaceable sodium is high, even though there may be considerable water-soluble sodium, and the active calcium is such that the ratio of active sodium to active calcium is approximately 2 or less, the soils are unproductive. Such a condition also indicates a soil with a high dispersion coefficient, and, if it occupies an area of much slope, erosion will be quite severe."

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The Present Status of Gas Storage Research, with Particular Reference to Studies Conducted in Great Britain and Preliminary Trials Undertaken at the Central Experimental Farm, Canada, *C. A. Eaves,* Sci. Agr., 15 (1935), no. 8, pp. 542-556, figs. 2; Fr. abs., p. 556. Following a general review of gas storage studies in Great Britain and elsewhere, the author reports that pure nitrogen atmospheres had a very harmful effect upon strawberries held at 54 degrees F. Raspberries lost their flavor in nitrogen at 32 degrees but maintained a pleasing appearance. High concentrations of carbon dioxide were found to decrease sweating, softening, and mold growth, and to maintain a bright, attractive appearance in both strawberries and raspberries. However, there was developed a bitter flavor. A maximum of 10 per cent carbon dioxide is suggested for raspberries, with 5 per cent at 32 degrees the optimum.

Physiological Behavior of Grimes Golden Apples in Storage, *P. L. Harding.* Iowa Sta. Res. Bul. 182 (1935), pp. 313-352, figs. 11. In respiration experiments with Grimes Golden apples stored at different temperatures it was found that respiratory activity is reduced to a minimum at temperatures such as 30 degrees F. When the temperature was alternated between 50 and 30 degrees the respiration rate followed closely. There was, however, no stimulation or depression in respiration rate beyond the point of fruits held constantly at the two temperatures. The life of fruits was prolonged by placing them in storage immediately after picking; in fact, the respiratory activity of apples just at the time of placement in storage served as an index to their storage capacity, particularly with reference to soggy breakdown. At a temperature of 50 degrees apples from high nitrogen plats respired consistently more than did fruit from check plats. At 30 and 36 degrees previous soil treatments were masked by the low temperatures. A higher percentage of soggy breakdown developed with deferred storage of fruit from the high nitrogen treatment than in that from the check plats.

Determinations upon Grimes Golden apples stored at different temperatures showed no consistent correlation between respiratory intensity and catalase activity. At 50 degrees catalase activity was apparently associated with respiration, whereas at 30 and 36 degrees no parallelism was observed. Fruits from nitrated trees showed greater catalase activity than did comparable lots from untreated trees. Catalase activity was considered an indication of physiological activities within the fruit, and under cold storage conditions an increase in this activity is a fairly accurate index to the approach of soggy breakdown. Oxidase activity, on the other hand, was not found to be significant as an indicator of the development of this disorder. In the case of deferred storage fruit held at 30 and 36 degrees and of immediately stored fruit held continuously at 50 degrees, catalase activity was more pronounced in the 30-degree lot than at the other two temperatures.

Influence of Different Quantities of Moisture in a Heavy Soil on Rate of Growth of Pears, *M. R. Lewis, R. A. Work,* and *W. W. Aldrich.* Plant Physiol., 10 (1935), no. 2, pp. 309-323, figs. 5. In this study, conducted near Medford, Oreg., by the Oregon Experiment Station and the U. S. Department of Agriculture, there are presented observations in three orchards, one of Bartlett and two of Anjou, all on *Pyrus communis* roots. There was noted a very close correlation between moisture and rate of growth in all cases. Under the obtaining conditions, the growth of the fruits was reduced whenever the soil moisture dropped below 70 per cent of the available capacity. The authors suggest that in the particular soil the actual moisture content adjacent to a portion of the active roots may possibly be down to the wilting point even though samples of soil taken in the general root zone may be well above the wilting point. The moisture supply may thus be determined not by the rate at which roots can take up water but by the rate at which the water can move through the soil to the roots. It was apparent that the growth of pear fruits may be influenced by comparatively small variations in soil moisture even when water is above the wilting point.

The Infiltration Capacity of Soils in Relation to the Control of Surface Runoff and Erosion, *G. W. Musgrave.* Jour. Amer. Soc. Agron., 27 (1935), no. 5, pp. 336-345, figs. 5. Pointing out that the amount of erosion occurring from a field for a rain of given intensity and duration may be approximately predetermined for a given set of conditions of quantitative data are available for (1) amount of water impounded upon the surface of the field by the treatment, (2) the rate of infiltration for the soil and conditions, and (3) the density of the run-off (pounds of soil per cubic foot of run-off) for the soil and the treatment, the author shows, from data obtained at the Iowa and Missouri erosion experiment stations of the USDA Bureau of Chemistry and Soils, that the amount of water impounded by such treatments as terracing, contouring, etc., is approximately determinable, methods and specific cases of the measurement of the infiltration capacity of field soils being given.

"Before erosion control measures are designed and recommended for general application in the field, their probable effect should first be calculated and the degree of protection which they afford compared with the rainfall records of the area."

Relation of Moisture Content and Method of Storage to Deterioration of Stored Cottonseed, *D. M. Simpson.* Jour. Agr. Res. [U. S.], 50 (1935), no. 5, pp. 449-456, fig. 1. Storage experiments with sea island and upland cottonseed under the humid conditions prevailing at James Island, S. C., demonstrated that in ordinary storage cottonseed deteriorates rapidly after 2 years. The moisture content of the seed during storage and rapidity of deterioration were definitely related. Sea island seeds, with a moisture content reduced below 8 per cent and stored in tin containers to prevent rapid reabsorption of moisture, retained their germination percentage with but slight impairment of 4½ years. Upland cottonseed stored under various conditions and containing from 8.75 to 13.78 per cent moisture deteriorated rapidly when the moisture remained above 10 per cent. Dried seed stored to prevent reabsorption of moisture showed only slight deterioration after 2½ years. Seed containing 13.78 per cent moisture and stored to prevent drying were all dead 9 months after storage began.

Precooling Investigations with Deciduous Fruits, *F. W. Allen* and *L. R. McKinnon.* California Sta. Bul. 590 (1935), pp 142, figs. 54. A summary is presented of the results of a large number of precooling tests, some carried on under commercial conditions and others in the experimental cold storage plant at the university farm, employing various fruits, including the apple, apricot, cherry, nectarine, pear, plum, peach, and grape. Data are presented on effective temperatures, time required to accomplish cooling to the desired degree, and on the beneficial effects of precooling. A general discussion is presented of precooling in warehouse rooms and in refrigerator cars and of methods of shipping precooled fruit, etc.

Nitrogenous Metabolism in Irish Potatoes During Storage, *N. W. Stuart* and *C. O. Appleman.* Maryland Sta. Bul. 372 (1935), pp. 191-214. Nitrogen distribution in Irish Cobbler and McCormick potatoes stored at 2 to —3 degrees C remained remarkably stable up to 5 months. A very slight protein synthesis had occurred in the McCormick variety toward the end of this low-temperature storage period.

Whole-tuber analyses failed to disclose changes in nitrogen distribution during the rest period. With the advance of senescence and sprouting of the tubers at room temperature or at constant temperature of 22 degrees, a very slight hydrolysis of the protein reserves occurred.

A difference of 4.5 per cent in the moisture content of the tubers due to different humidity conditions of storage had no effect on the nitrogen metabolism.

Potato sprouts were higher in total and residual nitrogen and much lower in basic nitrogen than the tubers from which they grew. The total nitrogen in a late crop of Irish Cobblers was much higher than in an early crop, but the proportion of protein to nonprotein nitrogen was nearly the same in both. Variable conditions of culture seem to induce chiefly quantitative rather than qualitative differences in nitrogen distribution in the tubers.

Considerable variation was found in the amounts of the nitrogen fractions in different parts of the tuber, the nonprotein nitrogen being much lighter in the medulla than in the cortex. The importance of this condition in relation to the cutting of tubers for seed is discussed.

A study of the nitrogen metabolism associated with the reversion of parenchymatous cells to embryonic cells of the new cork cambium which gives rise to wound periderm showed that the protein and basic nitrogen increase at the expense of the amino nitrogen. The amide fraction remains constant, and the amino acids rather than the amides are concerned in this regeneration of proteins.

The most important general deduction from the study concerns the very slight shifting in the relative proportions of the nitrogen fractions of tubers under any conditions during their natural storage life.

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SWEET POTATO STORAGE HOUSES, *E. R. Gross.* New Jersey Stas. Circ. 359 (1935), [pp. 4], fig. 1. Practical recommendations on the planning and construction of sweet potato storage houses to meet New Jersey conditions are briefly presented.

BIBLIOGRAPHY ON COMBINED HARVESTER-THRESHERS, compiled by *D. W. Graf.* U. S. Dept. Agr., Engin., 1935, pp. 23. This is a selected mimeographed list of references covering information from 1841 to 1935.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE IDAHO STATION. Idaho Sta. Bul. 217 (1935), pp. 10-12, 26, 43. Progress results are briefly presented of investigations on irrigation, drainage, and land development, Diesel tractors, alcohol-gasoline fuel, rural electrification, portable elevators, and farm water supplies.

Literature Received

A.S.H.V.E. GUIDE 1936. American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York, N. Y. 1166 pages, profusely illustrated, 6x9 inches, $5.00. This is the 14th annual edition of the A.S.H.V.E. Guide for heating, ventilating, and air-conditioning. It presents all the facts required to solve design problems in heating, ventilating, and air-conditioning, and gives authoritative practical, up-to-the-minute data for users to keep in touch with developments and also serve as a buying guide, as it contains descriptive material on new and existing equipment manufactured by leading firms in the industry. In it will be found entirely new data and fundamentals of refrigerating, air-conditioning for industrial process, drying, electric motors, stokers, unit heaters, condensers, coolers, and railway air-conditioning. The material which has appeared in previous issues of the Guide has been amplified and revised with many new drawings and tables to illustrate the text. The problems in practice have been retained and extended in scope and may be found at the end of each chapter. In the catalogue data section of 270 pages, 181 of the leading manufacturers have given detailed descriptions of the products that they make.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

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